Focus

December 2012

Property Cat: key strategic issues and trends ahead

SCOR Global P&C


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SUMMARY

Foreword

*After the record-breaking **catastrophe losses** in 2011, three benign quarters in 2012 were a welcome relief to an insurance industry still trying to make sense of the "surprises" thrown up from the losses in Brisbane, Christchurch, Tõhoku, the US Mid-west, and then Thailand. The "art of the science" of **Catastrophe Risk Management** had lessons to learn from the real world events of 2011, as well as the challenge of digesting major, and somewhat controversial, changes to the synthetic, modelled events driving **catastrophe modelling** views of risk for some peak, global hazards. And then, as if to mark the 20^{th} anniversary of Hurricane **Andrew**, "Superstorm **Sandy**" arrived, disrupting the US Presidential election run-in and causing devastating insured damage of US$ 20 billion+ to Northeast states, all this after having left a trail of havoc across the Caribbean.*

***Catastrophe models** are the Swiss-army knives in the **Cat Risk Management** survival kit – performing multiple functions for insurers including: pricing & risk acceptance decision support, portfolio accumulation management, capital modelling and business planning. Their use is widespread, and they have shaped the very language and framework with which the industry measures and communicates the direct financial risks associated with major natural disasters – and more latterly for man-made disasters too.*

*The events of 2011 and 2012 have given us all pause for thought, and to question whether these simplified mathematical representations of the destruction potential of incredibly complex natural phenomena will ever be rich enough to adequately capture the myriad uncertainties that lie in wait ready to produce the next "surprise" event: whether levee failure, record surge/cloudburst flooding, nuclear incident, tsunami, regional blackout or political intervention, let alone be sophisticated enough to effectively couple and model dependencies that invariably exist due to large scale weather patterns like **El Niño**, or the relationship between Property and Agriculture lines of business weather risks.*

*In the spirit of confronting all of these big questions, we decided to organise a seminar in June 2012 for our clients, brokers, rating agencies and regulators to take stock, and share SCOR's views and ideas around how to successfully manage the risks of the risk models. Twenty years ago, when Cat 5 Hurricane **Andrew** battered its way through Florida into the record books, **catastrophe loss models** were in their infancy. They have grown and matured a lot over that time in both geographic scope and sophistication, but now, after "Superstorm **Sandy**", they face the difficult transition from adolescence to adulthood. Industry talk of paradigm shifts may sound cliched, but we genuinely think that we may look back on 2011/12 as an inflexion point, a time when the expectations of how good is good enough changed, and the start of a new round of innovation and collaboration with the wider scientific, engineering and even political spheres.*

*This **SCOR Focus report**, based on the presentations made by the speakers at our seminar, aims to bring the insights shared with a wider audience of clients and other interested stakeholders that were not able to join us in the Auditorium of SCOR's new headquarters on Kleber Avenue.*

*Since **Sandy** occurred after the seminar this report does not contain an article dedicated to the specific challenges and issues this major event has raised, or those that are undoubtedly yet to surface. These will have to wait for a future seminar and subsequent publication. In the meantime, we take this opportunity to identify factors that we already know will need to be woven into future model changes, or internal adjustment of model results. These are:*

- *The flood/wind coverage challenge for US tropical storms will be an inevitable tension, seen before in Houston's Tropical Storm **Allison**, and writ large in New Orleans **Katrina**.*
- *The related question around the sustainability of the heavily indebted, perennially "underwater" **National Flood Insurance Programme** (NFIP), will spark calls for reform and/or a broader **Federal National Catastrophe Pool** with implications for the industry.*
- *The treatment in **Cat models** of the attendant pollution, (contingent) business interruption, post-loss amplification, loss adjustment expenses, transit systems, ports, marinas, tree damage, inland flooding, "hurricane" deductibles, Thanksgiving looting.*

*All these topics would provide us with ample material for an entire seminar, and we hope that many of you will be able to join us in 2013 as we incorporate learnings from **Sandy** into our view of modelled risk.*

*Finally, we would like to take this opportunity to thank all those who contributed to both the seminar and this **Focus publication**, including speakers and panellists whose biographies are included.*

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The views and statements expressed in this publication are the sole responsibility of the authors.

1

CAT RISK: WHICH STRATEGY AFTER 2011?

DENIS KESSLER
Chairman & Chief Executive Officer
SCOR SE

The exceptional natural catastrophes recorded in 2011 led to massive losses for the insurance and reinsurance industry, with costs of more than US$ 100 billion. The financial impact was dramatic for many reinsurers. Moreover, a significant share of these losses occurred in non-peak regions and related to non-modelled perils, which raises the issue of just how sophisticated the models used by the (re)insurance industry actually are. These two points have driven some reinsurers to reduce their exposure, or even to pull out of certain catastrophe-prone markets.

This situation has led us to the conclusion that now is the right time to reflect, along with our stakeholders, on the main issues relating to natural catastrophes, and on possible strategies for the future.

SCOR considers natural catastrophes as a key element to be taken into account at every level of the company, whether on the financial side, the liability side, the capital or the IT side. A global view of natural catastrophes is necessary in order to convince the company's stakeholders of its capacity as a shock absorber.

SCOR's consistent strategy

Building a strategy is quite similar to building a house. In both cases, cornerstones are the solid foundations that enable the construction to resist shocks and the tests of time. Eight years ago, SCOR chose 4 cornerstones on which to base its strategy, and has not deviated from them since:

- Strong franchise,
- Controlled risk appetite,
- High diversification,
- Robust capital shield.

Each of these principles is essential to SCOR's approach to the natural catastrophe business. The answer to large Cat losses is not to flee, but to find new protection mechanisms, and to innovate in order to increase and improve reinsurers' shock absorption capacity. As part of the improvement of its strategy and its natural catastrophe-oriented Risk Management, SCOR has been developing better analysis, quantification and management of Cat risks since 2011.

The year 2011 has been referred to as an "*annus horribilis*": from Japan to Australia and New Zealand, it was a record year for natural catastrophe losses, following on closely from those of 2005. In this volatile environment, reinsurers have played the role of shock absorbers. One of their intrinsic characteristics is to survive these shocks, and still be able to provide coverage, services and capacity to their cedants. The only way to do this is to apply a very precise procedure, which consists of identifying and then quantifying uncertainties, and preventing and hedging risks.

However, reinsurers have to prove their company's strength not just to their cedants, but also to their shareholders. Given the reluctance of shareholders to be exposed to natural catastrophes, reinsurers' share prices tend to drop in the wake of major natural catastrophes, and shareholders are inclined to question the company's Nat Cat strategy.

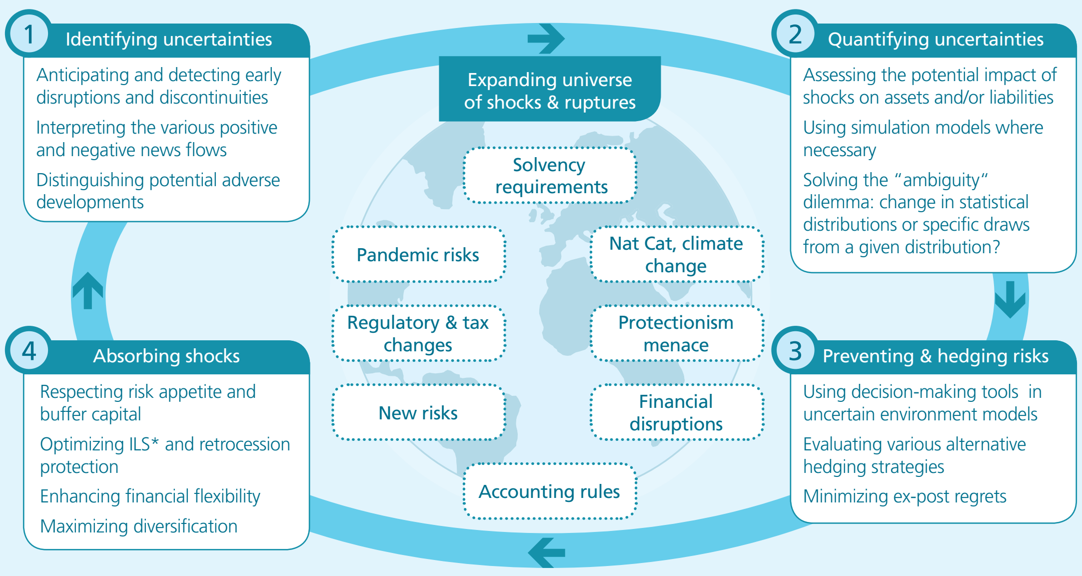
The key to this problem lies in information and planning: in a well-run company, Cat exposure is integrated into the share price, and shareholders are well informed about the group's exposure to natural catastrophes. This method allows SCOR to remain constant in its strategy, but also to protect its portfolios and balance sheets even after exceptional losses.

In such circumstances, reinsurers have the choice between two attitudes: they can either adopt an opportunistic approach, i.e. move in and out of markets according to conditions, or they can choose a long-term commitment, and cultivate an almost symbiotic relationship with their cedants. SCOR believes in the sharing-of-fortune view, where the two parties share each other's ups and downs. However, this relationship must be balanced in order to be mutually profitable.

Durable commitment fits in with SCOR's strategy, in the sense that providing capacity in tough times is an essential part of the value proposition of reinsurers over the long term.

How do you justify premium rates if reinsurers are only providing sporadic capacity? The worst thing for the market is disruption or discontinuity. The role of reinsurers is to continue to supply capacity after important shocks. SCOR stayed true to this belief and did not reduce its overall exposure to natural catastrophes after the exceptional 2011 series of events, even increasing its exposure to US wind in line with the company's risk appetite and strategic plan. The market has a memory, and defection is not well perceived – it is difficult to do business with a partner who has not demonstrated commitment in times of adversity.

Figure 1: **The expanding universe of shocks and ruptures**



** ILS: Insurance-Linked Securities*

STRONG FRANCHISE

For SCOR, having a strong franchise means demonstrating excellence in terms of expertise and innovation. Natural catastrophe analysis has progressed over time, along with our expertise in this field. This progression goes hand in hand with innovation: SCOR is currently developing two Cat projects in order to improve its analysis, quantification and management of Cat risks.

A joint development project with RMS (Risk Management Solutions), called the Cat Platform, has recently been launched. This new tool enables the company to streamline portfolio accumulation processes with real time integration into SCOR's contract management system OMEGA. OMEGA is a unique, worldwide IT system, developed over the last 17 years, which gives SCOR a comprehensive and holistic view of its Cat exposure, whether from Treaty, Facultative or Life contracts. The new Cat Platform will also ease the blending of RMS' views with the Group's own internal Cat models. It is essential for SCOR to develop this Cat platform, because external models cannot fully encompass all reinsurance activities.
Moreover, Solvency II, as a risk-based solvency approach, rightly insists on the need for insurers and reinsurers to understand and monitor their risks themselves, without relying on black box software, however sophisticated it may be. We are convinced that external and internal tools must be used together in order to ensure optimum results.

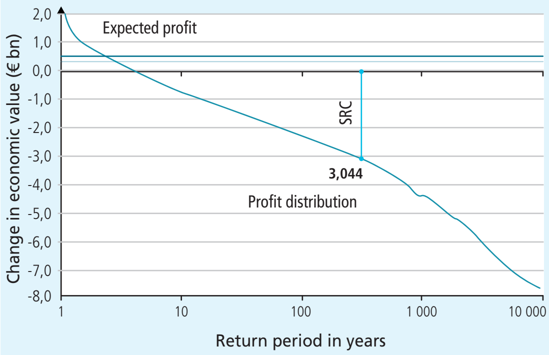
SCOR also supports a new open-architecture Cat modelling initiative called OASIS, with two objectives in mind: firstly, it will help to validate the existing suite of vendor models, as it is important to estimate the value of such tools, their shortcomings and also their advantages. Secondly, it will make the development of new models easier for territories that are not currently supported by the main vendors. This project has to be considered more widely in connection with the 2011 Thai floods, where there was no available tool to estimate such a major event for the industry.

CONTROLLED RISK APPETITE

Setting up a clear strategy for natural catastrophes also requires a controlled risk appetite, which is an essential concept for reinsurers. A precise definition of risk appetite should be addressed to shareholders. Transparency of information is an important component of the risk appetite definition, in order to reconcile shareholders' risk adversity and their desire to improve the profitability of the company. Defining and controlling the company's risk appetite for non-peak and especially non-modelled risks may be a challenge, but this does not mean that these specific risks cannot and should not be managed.

As shown in Figure 2 below, a well-defined risk appetite always involves a trade-off between risk and return. SCOR has opted for what we call mid-level risk appetite, and we accept risks only if they fit our risk appetite. The objective is not to seek extreme profitability, but to achieve a robust profitability while reducing the volatility of the bottom line and protecting our shareholder base. This definition is a way to ensure that, whatever happens, we protect the company's shareholder base and we can continue to supply capacity to the market in the coming year.

Figure 2: **SCOR's risk profile is consistent with its risk appetite**



At the 1 in 200 period, which corresponds to the Solvency Capital Required (SCR) (Value at Risk (VaR) at 99.5%), SCOR losses would amount to approx. € 3 billion

The year 2011 stands out not just in terms of the magnitude of the losses incurred, but also because of the unusual location and nature of the events that took place. In this example, half of the losses were located in non-peak territories such as Thailand, Australia or New Zealand, whereas reinsurers devoted their attention to peak territories.

Moreover, reinsurers were confronted with floods and earthquakes in 2011, but with few wind-related catastrophes, unlike in previous years. Non-modelled perils accounted for 28% of the insured costs, a significant percentage compared to previous years. "Non-modelled" may have different meanings: sometimes the event itself is not modelled, such as the Copenhagen floods, in other cases it is the secondary perils that are not modelled, such as the tsunami that followed the Japan earthquake, and occasionally the deficiency relates to the way in which the consequences for the insured are assessed, as happened with the Thai floods and the supply chain disruptions which followed.

HIGH DIVERSIFICATION

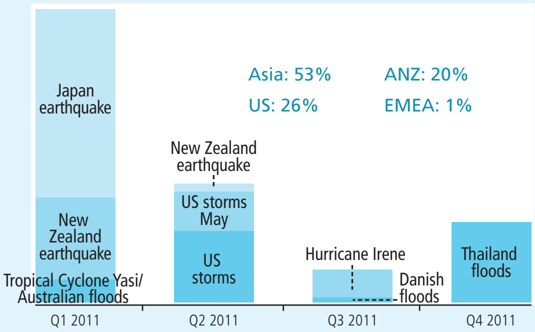
Despite the criticism that diversification has had to face over the past few months, and the terms coined to achieve this objective, such as di-*worse*-ification or diversi-*fiction*, SCOR still strongly believes that high diversification leads to better management of risks. This practice allows the company to save capital and to preserve its solvency and stability. Diversification can take various forms: it can be geographical, or it can mean exploring different lines of business, but it will remain an essential part of the value that reinsurers bring to the market. This is clear from the fact that today's most successful reinsurers are global players.

To start with, a look at diversification within lines of business may be interesting: one of SCOR's stand out features is that we have developed what we call a twin-engine approach, an almost 50-50 split between Life and Non-Life business. This strategy takes advantage of the low correlation between these two lines of business, and can resist very large events like those of 2011.

Geographical diversification is also a key asset of the Group. As a matter of fact, it is common knowledge that natural catastrophes do not always happen in the same area, as the Figure 3 illustrates. In 2005 Katarina, Rita and Wilma struck the Southern United States, and in 2011, southern Asia-Pacific was hit.

When diversified with other lines of business and with reserves, Cat risk becomes less capital-intensive. Diversification by client, market, or even by peril, enables the company to absorb a very large amount of risks.

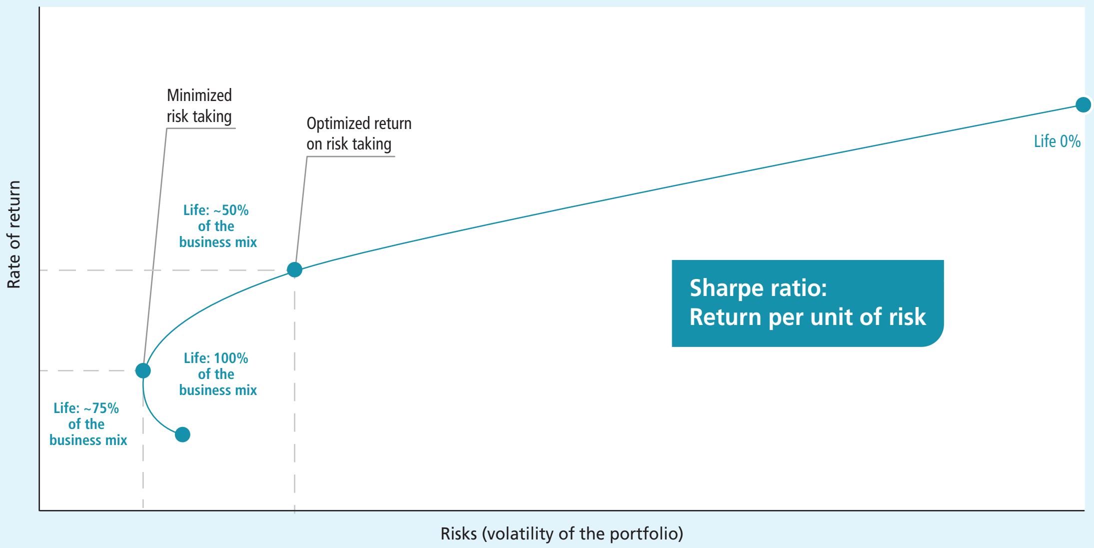
Figure 3: **2011 large loss allocation**



Source: Guy Carpenter, 2012

However, simple diversification is not enough: reinsurers must seek optimal diversification of their portfolio in order to maximize the benefits of this practice while minimizing its cost. While creating its portfolio, SCOR tried to achieve the maximum rate of return for an acceptable level of volatility. All the correlations between lines of business and perils were carefully considered in order to create SCOR's internal model; furthermore, there was a major focus on assessing all of the correlations between Life and Non-Life lines of business, in order to minimize capital requirements. We estimate that the combination of Life and Non-Life allows SCOR to save around 30% of capital at a Group level, as compared to pure Life or Non-Life players, which is a huge amount.

Figure 4: **Risk/return curve based on the Life/Non-Life business mix**



ROBUST CAPITAL SHIELD

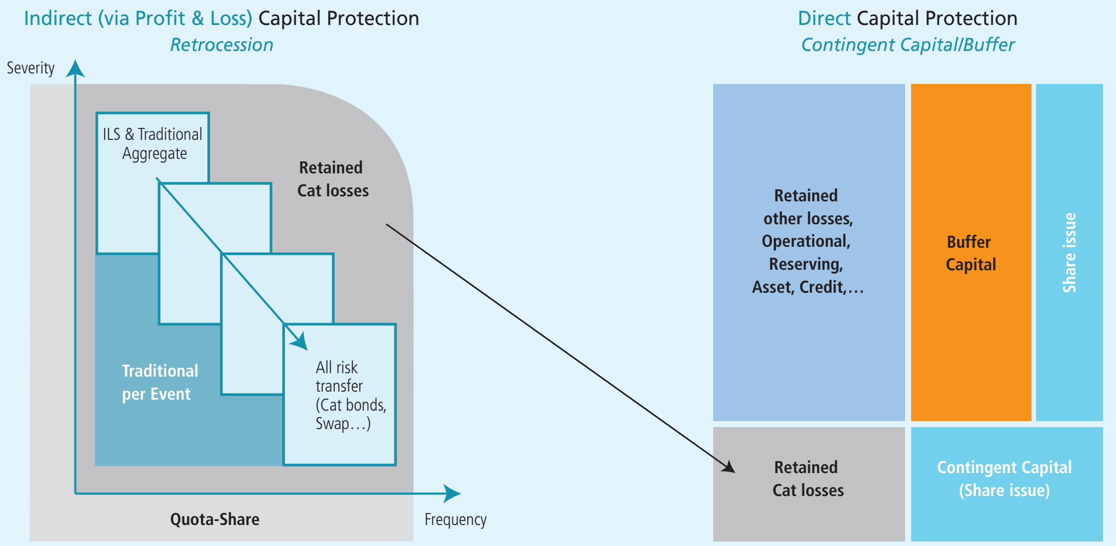
The implementation of capital shield policies is one of the practices that has enabled reinsurers to weather the Cat events of the last few years. When defining the company's risk appetite, we need to bear in mind the protection of the capital base, and hence the Group's solvency.

SCOR has designed its capital shield to be particularly robust. It consists of four articulated layers:

1. Retrocession: SCOR decides to retrocede a part of the risks it underwrites. We have always believed that a substantial level of retrocession is essential. Even after the events of 2011, 70% of our cover was still available at the end of the year, thanks to the different types of retrocession that we had set up.
2. Alternative risk transfer solutions: SCOR uses tools such as ILS (Insurance Linked Securities) or Swaps. These instruments are an opportunity to diversify our protection through access to new sources of capital.

   Today, the Cat bond market has grown to nearly US$ 14 billion, reaching levels last seen in 2007. This is something that can benefit both cover buyers and investors, who are looking for uncorrelated, absolute returns. With this in mind, SCOR has launched a fund called Atropos, which is dedicated to Insurance Linked Securities and mainly consists of Cat bonds, with an initial commitment of US$ 100 million.
3. Buffer capital: SCOR includes a buffer capital in its internal model, and has designed it in order to prevent its available capital from falling below the level required by regulators, except in low-probability scenarios.
4. Lastly, our contingent capital facility. This is an innovative solution launched in September 2010, which enables the company to automatically obtain additional capital from the market when a certain trigger is activated. This happens when the level of estimated net natural catastrophe losses incurred by SCOR reaches a pre-defined threshold. This is a very satisfactory solution because it is less costly than equity, but it also offers a level of protection that is recognized by the rating agencies.

Figure 5: **SCOR capital shield framework (illustrative)**



To improve their efficiency, these 4 layers must be optimally combined. The objective of this strategy is to protect the Group's capital base, minimize costs and maximize benefits. The capital shields protect our solvency even in the most extreme cases: in spite of all the natural catastrophes absorbed in 2011, net losses after retrocession amounted to only 15% of shareholders' equity, making SCOR one of the least hit reinsurers. SCOR has thus been able to maintain the quality of the financial protection offered to its clients.

Since 2007, on top of shocks on the liability side, the world has been through a tough financial crisis, and reinsurers have had to weather a series of external shocks on the asset side, where the returns have been divided by half. However, throughout these years, reinsurers have never failed their clients, and their capital base has remained almost unabated. These elements clearly demonstrate the resilience and robustness of our business model.

After all the shocks, and all the difficulties that we have experienced over the past six years, I believe that the four cornerstones of this Group have demonstrated their relevance. If I had to add another cornerstone to this list, it would be consistency. You must have geographical consistency, and maintain a global, holistic view. You must also have time consistency, which at SCOR means sticking to a mid-term/long-term view.
This is why we have three-year plans, and why we don't deviate from the targets and constraints set out in them. I believe that this is highly reassuring for SCOR's clients and shareholders.

2

NON-PEAK, NOT MODELLED: NO EXCUSE FOR NOT MANAGED

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Without doubt, the widespread industry adoption of catastrophe risk modelling has played an important role in enabling the global insurance and reinsurance industry to absorb over US$ 100 billion of insured losses from the natural disasters occurring in 2011. However, in spite of the advances in Cat risk modelling tools [(1)] over the last twenty years, there are gaps in global coverage and some material limitations of the current suite of risk models. This article discusses the challenges that remain in terms of quantifying and managing these *non-modelled* risks.

Model blindspots

Major natural disasters represent existential risks to Non-Life (re)insurers, triggering thousands of claims simultaneously and constitute tail events beyond the historical claim experience of insurance companies in the modern era. Catastrophe risk models have developed to help the industry to better understand the shape of the tail of the risk distribution and draw on scientific and engineering knowledge, calibrated with actual damage and claim information wherever possible. Using simulation techniques the mathematical models build up a probabilistic picture that describes the loss potential of extreme events and this helps insurers to structure appropriate risk transfer mechanisms such as reinsurance, to manage risk and protect the balance sheet.

While peril coverage is generally good for large mature markets representing peak global risks (in the USA for example there are commercially available models for earthquake, hurricane, tornado/hail and winter storms), there are gaps, particularly in developing economies where industrialisation and an emerging middle class are drivers of increasing demand for insurance, creating new concentrations of risks exposed to natural hazards. The economic success story of Thailand in attracting foreign direct investment in the manufacturing sector, gave rise to a number of huge industrial parks that was clearly not matched by the development of catastrophe models to adequately quantify the flood risk.

Even within the current suite of models we must be mindful of certain limitations in terms of completeness. The extreme events of *annus horribilis* [(2)] 2011 gives us plenty of examples of grey swans, where the non-modelled impacts cannot be considered as Rumsfeldian *Unknown Unknowns* or *true black swans* in the sense that Nicolas Taleb describes. The March 2011 Tōhoku earthquake serves as a stark example of the aggravated loss potential from so-called secondary perils such as tsunami, which accounted for between 15% and 30% of cedant losses; tsunami damage is not explicitly considered in any of the current generation of Cat models used by the industry.

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(1) There are 3 major specialist suppliers of global "Cat" models to the industry: AIR, RMS & EQECAT.
(2) Geneva Association report on the events of 2011, Extreme Events and insurance: 2011 annus horribilis http://www.genevaassociation.org/PDF/Geneva_Reports/GA-2012-Geneva_report[5].pdf

Tōhoku also serves as a reminder of the inherent uncertainties in trying to model extreme events since the magnitude of the earthquake fell outside the expectations of the wider scientific community and the parameterisation of the mathematical models, not to mention the cascading effect of damage to Fukushima nuclear power plant. Similarly, the series of earthquakes in the Canterbury region of New Zealand provides new insight into the local seismic setting and a better understanding of liquefaction that needs to be incorporated in future model updates. Supply chain disruption in both Japanese and Thai events helps remind us that the insurance industrys tools and data still need to improve before we can model Contingent Business Interruption with any degree of fidelity.

Flight over the Sendai Airport in Japan after tsunami

Bridging the gaps

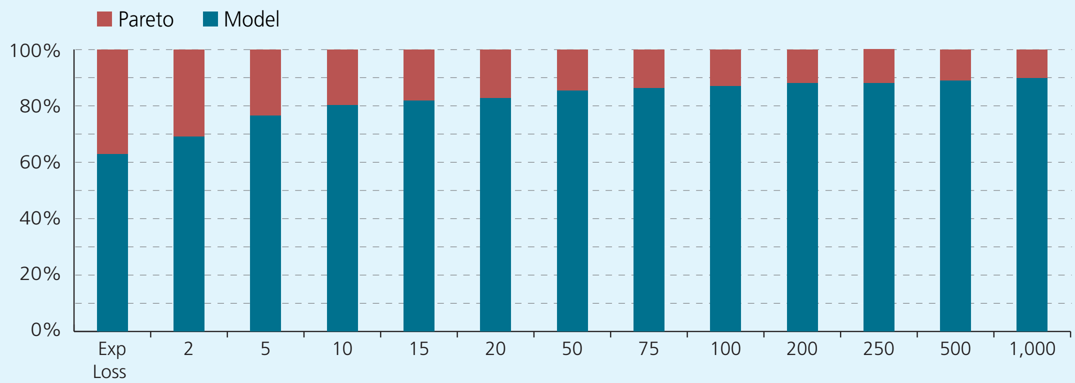
The gaps and limitations in the Cat modelling toolkits that the industry uses present a serious challenge, particularly for reinsurers with a globally diversified portfolio of natural catastrophe risk. It is clear from the events of 2011 that the gaps are not *de-minimis* and the expectations of key external stakeholders, including regulators, rating agencies and investors are for a comprehensive catastrophe risk management framework to ensure appropriate capital is in place to support the risk profile.

To achieve completeness in its modelling of global perils SCOR supplements its use of external catastrophe models in a number of ways. Where models exist but have important missing components we often extend the vendor model framework, for example we have developed an internal approach to reflect the missing tsunami component of loss for our Japanese event catalogue. In a number of countries where scientific hazard-based models are not yet available we have developed our own models internally. For other countries where models do not yet exist we build a statistical representation of the risk in each region/peril.

Key to supporting this is the detailed segmentation of expected catastrophe losses by peril/territory maintained in our pricing tool coupled with careful tracking of our natural catastrophe liability. This data is then used to parameterise a Pareto distribution of gross loss for each non-modelled peril which feeds into the global all perils Cat risk profile.

Figure 1 shows that the Cat model based peril losses constitute an increasing proportion of loss outcomes at the risk beyond higher return periods, while the Pareto based, *non-model* perils play a more significant role for shorter return periods. This follows from the fact that higher frequency/lower severity perils, such as flood, hail and bushfire are not well covered in the modelling tools. Flood in particular is technically very challenging to model insurance losses robustly, requiring complex interactions between precipitation, run-off/absorption, river flow modelling with topographical effects and the highly localised event damage footprints demands very detailed data related to the location of insured assets.

Figure 1: **Contribution to Tail Value at Risk (TVaR) by return period from "non-model" perils**

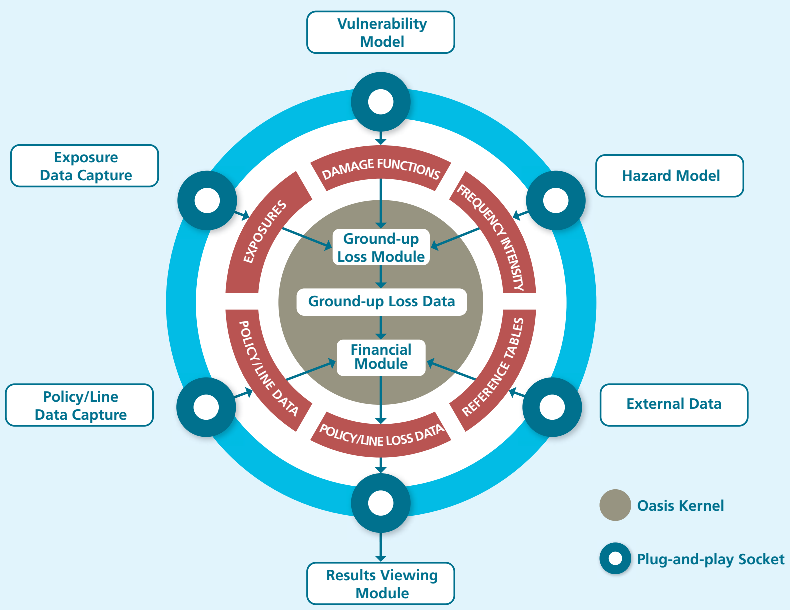


Creating an open architecture for future Cat loss models

As discussed above, while the development of science/engineering-based catastrophe models has served the industry well, the body of scientific understanding in wider academic and governmental research institutions continues to grow at pace which is not matched by our ability to incorporate new knowledge quickly. Recent examples include the findings of an expert panel commission by the Japanese Cabinet Office to look at tsunami risk, as well as an emerging scientific view of the effect of seismic stress transfer post-Tōhoku on future earthquake probabilities. This will take time to integrate into future models. A major constraint on the industry's ability to embed the latest scientific knowledge into our risk management frameworks stems from the fact that it is largely mediated by just three specialist companies with limited resources.

To address this model development bottleneck, SCOR is supporting a new initiative called Oasis [3] to create an open architecture framework for catastrophe modelling. This will enable a much wider community of technical experts to provide data or model components into a more modular plug-and-play framework. In developing the framework, Oasis is currently working with a major meteorological office as well as specialist flood and earthquake consulting firms and taking advantage of the latest technology in terms of massively parallel processing, and scalable cluster/grid solutions. There is also engagement with other related initiatives such as GEM [4] and the EU ClimateKIC [5] to allow convergence of standardised data interfaces between the model components.

Figure 2: **The Oasis loss modelling framework**



What the Oasis framework will do is enable model users to undertake full uncertainty calculations within a given model combination as well as testing a variety of models to illustrate the sensitivity of results to model choice. This will certainly support (re)insurers in demonstrating to regulators a detailed understanding of the models used by the business and their inherent uncertainties.

In conclusion, as an industry we simply cannot afford to ignore non-modelled perils, and it is important that insurers and reinsurers develop approaches to bridge any gaps in their risk management and capital modelling frameworks. New initiatives such as Oasis will help support the creation of alternative models for existing perils, and new models for so-called un-modelled perils and territories.

(3) Oasis is a not-for-profit organisation initially funded by subscribers from the insurance industry (cf. description page 24).
(4) GEM is the Global Earthquake Model initiative.
(5) ClimateKIC (Knowledge and Innovation Community) is an EU funded programme connecting a number of climate research institutions in Europe.

3

NAVIGATING MODEL CHANGE

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Catastrophe models are embedded in the insurance industry: the analysis of exposure, hazard and vulnerability provided by Cat models forms an integral part of the risk assessment routinely undertaken by insurers, brokers and reinsurers, to quantify their own potential losses or those of clients. As well as helping to understand cedants' losses, the use of market exposure databases, together with stochastic event set hazard components and vulnerability modules, can inform a market-level view of Cat risk. Although these models were initially designed to assess tail-risk, they are becoming increasingly integrated in the risk transfer/risk management workflow and now inform multiple aspects of the business, from pricing to capital requirements.

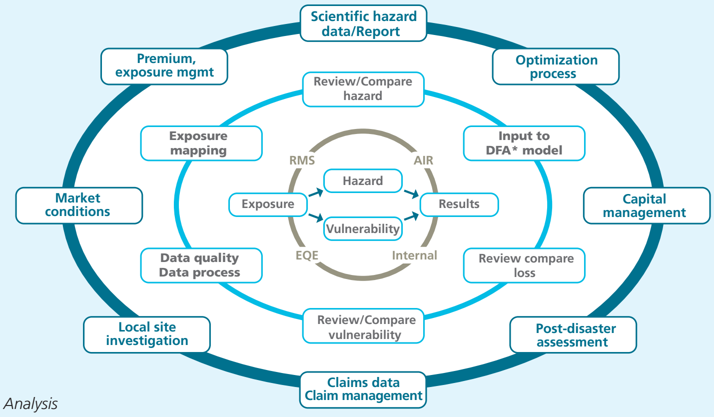
Cat models are becoming ever-more sophisticated as the underlying science and understanding of extremes evolves. As new knowledge is gained, model versions are updated. Implementing these new models to incorporate an updated view of risk, without disrupting the business workflow, is challenging. The transition must be managed carefully. This paper presents some of the principles underlying SCOR's model change guidance, illustrated by the European Wind model, which was comprehensively analysed as part of the SCOR model change management process in 2011.

In order to adopt a new model, the model must be well understood and its representation accepted as credible by the organisation using it. To achieve this, we recommend three levels of investigation:

- **Model comparison**: compare model results between different vendor models, across different versions/vintages of the same model.
- **Component review**: extensive review of the core components of any model, i.e. hazard, vulnerability and exposure – a fundamental step.
- **Model validation**: using external sources to challenge model output.

This process for navigating model change is illustrated in more detail in Figure 1. The first ring represents model comparison, the second component review, and the third model validation. In the following sections, we will illustrate each of these stages of managing model change with specific reference to the Eurowind model, followed by a couple of other short case studies.

Figure 1: **Navigating model change using model comparison (first ring), component review (second ring) and model validation (third ring)**



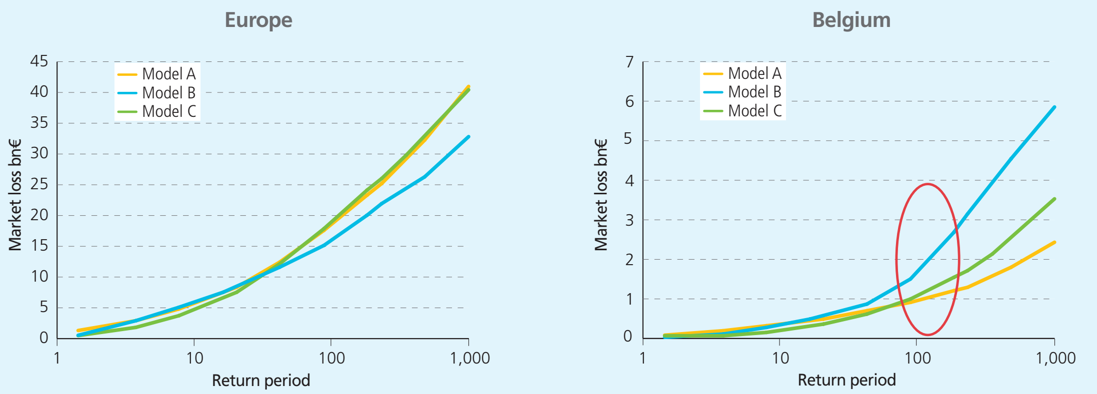
* DFA: Dynamic Financial Analysis

Model comparison

Model comparison simply means comparing the output of different models: this can be done on an industry basis, for a uniform portfolio or for a specific insurance or reinsurance portfolio. It is important to look at a broad selection of risk metrics, i.e. VaR (Value at Risk), TVaR (OEP[1] and AEP[2]) and annual mean loss, all of which provide insights into the behaviour of different models.

An example of an OEP VaR comparison between two models is shown in Figure 2. Considering the Eurowind industry portfolio (i.e. France, Germany, United Kingdom, Benelux and Scandinavia) on the left, we see that the loss estimates do not change greatly from one model to another with respect to 1 in 10 to 1 in 100 year return periods. However, at individual country level (right), much larger differences arise.

Figure 2: **Model comparison using industry exposures: for all Europe (left) and Belgium only (right)**



Since the models also provide representations of historical losses for benchmarking, it is important to understand how the representations of these and their modelled return periods change. Our analysis of Eurowind showed considerable variation in the monetary value of the losses themselves and the implied return period, both between vendors and versions from the same vendor. Drilling down further (by Line of Business) and sub-region) revealed even greater differences. It is important to comprehensively understand the loss behaviour of the model and its response to specific portfolio characteristics. This is the first step in accepting the model.

(1) OEP – Occurrence Exceedance Probability, describes the likelihood, often expressed in terms of Return Periods, of sustaining loss equal to or exceeding a given threshold from the largest loss in a modelled year.

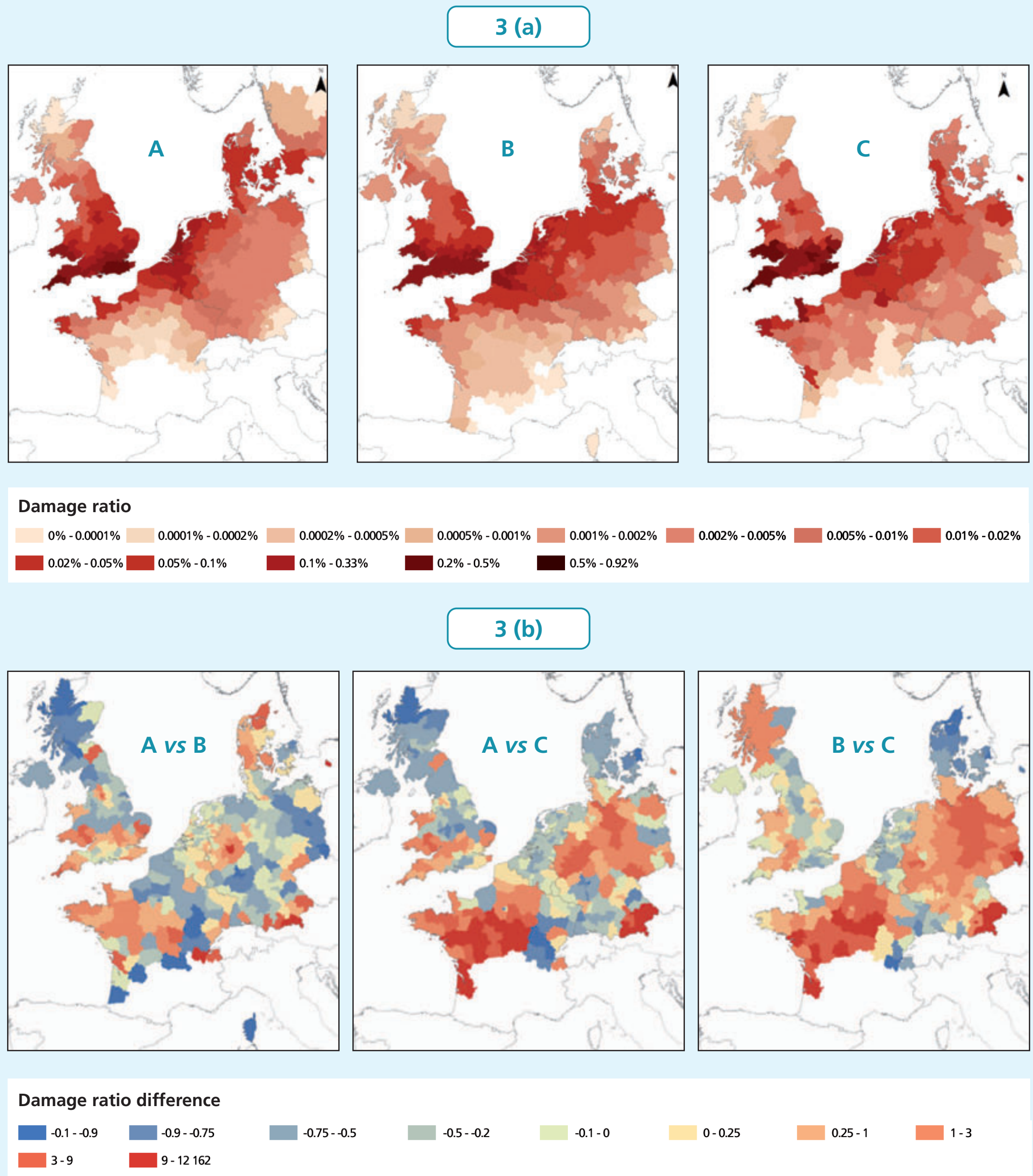
(2) AEP – Aggregate Exceedance Probability, similar to OEP but the probability that the sum of all losses in a modelled year exceed a given threshold.

Component review

All Cat models have a common "grammar": they have a standard structure comprising the stochastic generation of events, a hazard module and a vulnerability module, and use exposure information describing insured assets and policy terms inputs. This standard structure enables comparison of the model components. The impact of a module component on the overall losses for an individual model can also be measured.

Figure 3 below shows an example of component investigation using model footprints for the 1990 storm Daria across three different models. The top maps provide the level of damage by CRESTA[3] of the three different models for that storm; the second set presents the differences in the modelling. Figure 4 shows the return period of those damage ratios as per CRESTA.

Figure 3: **Mean damage ratios (loss/exposure) by CRESTA area for the three different models. (a) Daria footprints for models A, B & C respectively; (b) and the pairwise comparison of these**

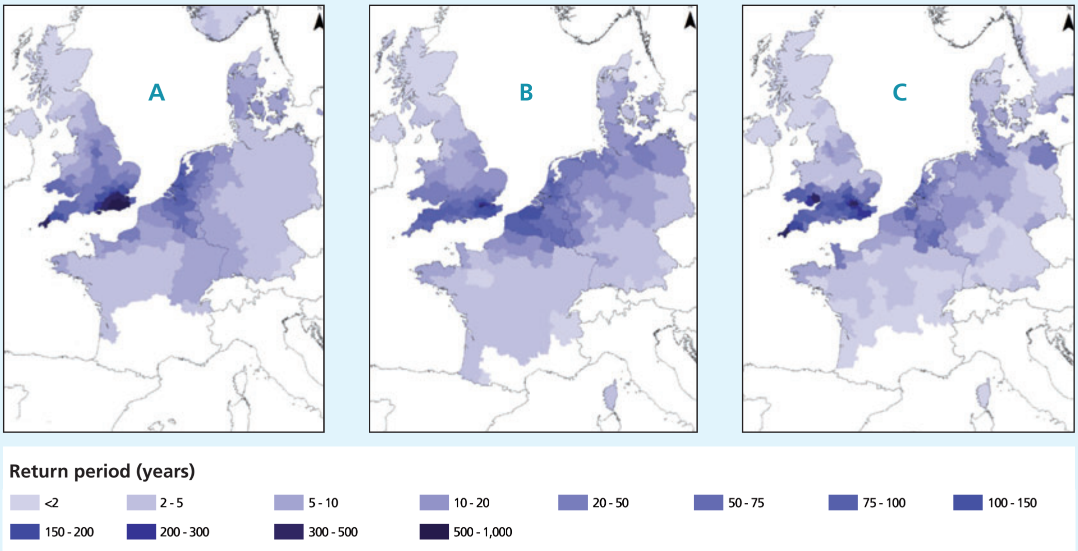


Although we see a broad agreement on a regional basis (a), there are significant local differences between the models (b).

(3) CRESTA: Catastrophe Risk Evaluating and Standardizing Target Accumulations.

When considering the return period of these damage ratios in each model (Figure 4), we can see that the damage ratios for the Daria footprint correspond to an approximate return period of 1 in 500 years around London. This value suggests that that either the historical footprint loss is overstated, or the losses generated by the stochastic set are insufficiently severe.

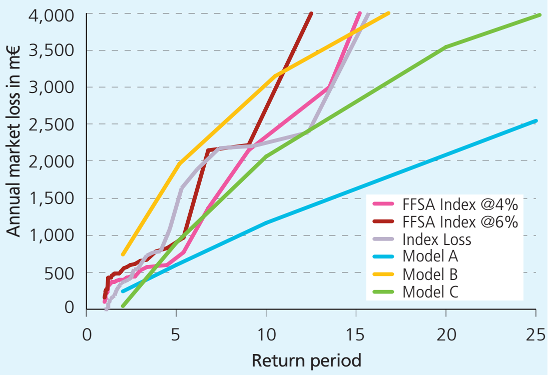
Figure 4: **The return period of modelled Daria damage ratios by CRESTA location**



Model validation

In the third level – model validation –, data or information are taken from outside of the modelling world to compare with model results. As an example, in Figure 5 we compare historical loss from the insurance association of France (FFSA) with 2 simple indexations (i.e. 4 and 6%) in order to represent a lower and an upper bound. We then compare with vendor models using the industry-wide losses, allowing us to observe and compare the range of results at low return periods. It seems in this case that model A is too low, whereas model C is too high. This can have serious implications if using models to price contracts attaching within that range. This type of analysis enables further challenge of the models and provides benchmarks to independently assess how they behave.

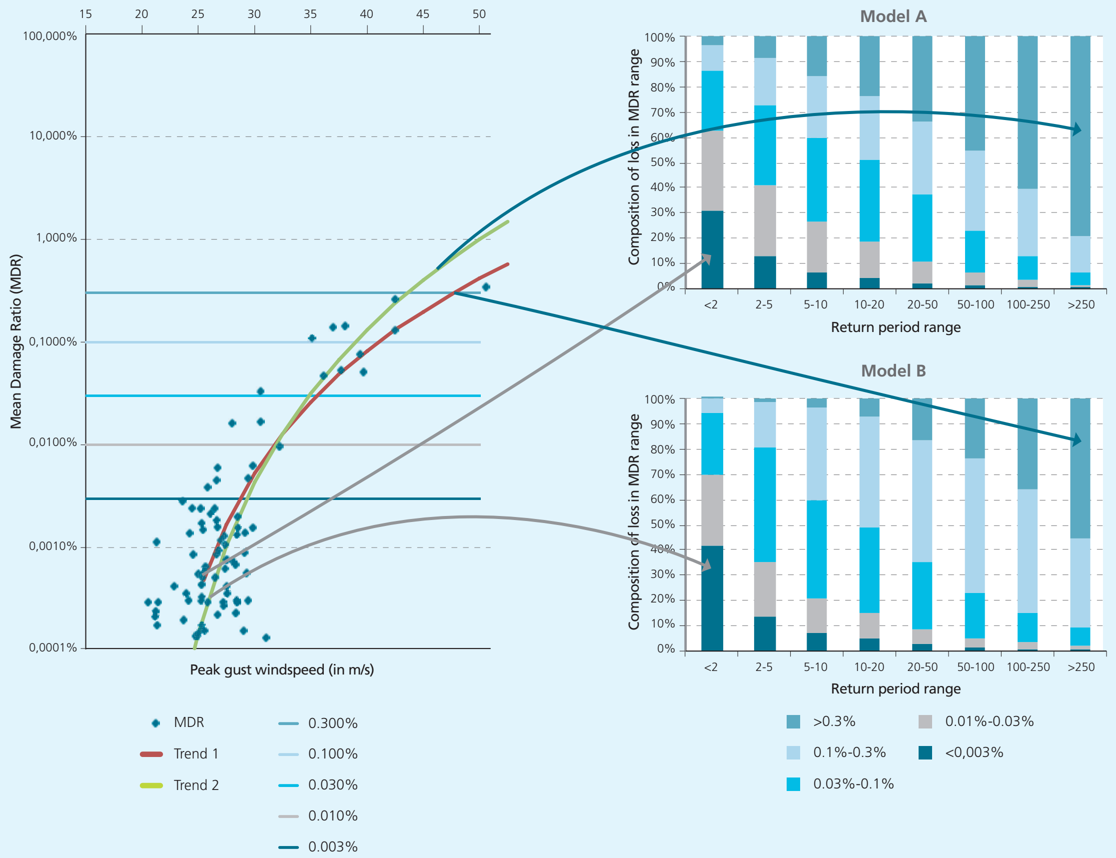
Figure 5: **Comparison of modelled output with "real world" data from the FFSA, indexed in 2 ways**



Understanding model limitations

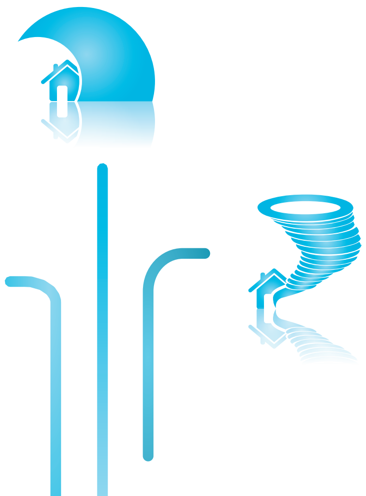
Understanding the limitations of models is essential to their appropriate use. There are many sources of uncertainty that propagate through the modelled system; some are quantified, others are not. The example in Figure 6 below shows how much of the tail risk is driven by different portions of the vulnerability curve.

Figure 6: **A vulnerability function for European wind (left), with the portions of the tail risk coming from that curve in the two models (right)**



This allows us to understand how much of the vulnerability curve is derived from wind speeds where data have historically been available (i.e. "observed" damage) and how much comes purely from extrapolation.

This type of exercise gives us more insight into some of the hidden uncertainties within the model.



Digging deeper: correlation between countries

The correlation or dependency between countries in European-wide portfolios (insurance or reinsurance) is very important. Even if individual markets behave quite similarly, the size and distribution of windstorms can mean that the combined portfolio behaves very differently. Figure 7 shows the amount of correlation from pairs of countries from various models and using 37 years of history. The models show a level of correlation between The Netherlands and the United Kingdom far below what has been observed historically. Knowing such information is critical when it comes to making strategic decisions, such as the marginal impact of deploying additional capacity in a given country in Europe.

Figure 7: **Country pairwise correlation**

Severity correlation for events between 5 and 50 Year Return Period

		Value					Delta vs Index Loss				
		DK	FR	DE	NL	UK	DK	FR	DE	NL	UK
Index Loss	DK										
	FR	-0,02									
	DE	-0,01	-0,02								
	NL	-0,01	-0,03	0,33							
	UK	-0,01	0,02	0,09	0,86						
Model A	DK										
	FR	0,00					0,02				
	DE	0,10	0,15				0,12	0,17			
	NL	0,08	0,09	0,54			0,09	0,11	0,21		
	UK	0,06	0,18	0,23	0,32		0,07	0,17	0,14	-0,54	
Model B	DK										
	FR	0,01					0,03				
	DE	0,15	0,14				0,16	0,16			
	NL	0,10	0,15	0,45			0,11	0,18	0,12		
	UK	0,10	0,09	0,11	0,17		0,11	0,07	0,02	-0,69	
Model C	DK										
	FR	0,12					0,14				
	DE	0,26	0,44				0,28	0,46			
	NL	0,30	0,32	0,62			0,31	0,35	0,29		
	UK	0,24	0,21	0,26	0,38		0,25	0,19	0,17	-0,48	

Conclusions

Model change can be tricky to navigate. Although the risk itself does not change, our representation of it does – this can be likened to the development of maps throughout history. To navigate successfully, you first need to know where you are! Therefore, SCOR's advice to best deal with model changes is as follows:

- Appreciate differences in methodology and losses for your different models.
- Build benchmarks in order to contextualize model results.
- Stress test assumptions in the light of the cost of particular assumptions to your business.
- Develop your own view of the risk.

Catastrophe models provide a framework to aid decision-making and will never replace business judgement. Understanding model behaviour, benchmarking and stress-testing are essential when developing your own view of the risk and will help you to successfully navigate the rocky waters of model change management.

4

CAT MODELLING FOR THE MASSES

PETER TAYLOR
Technical Director – Oasis

The insurance industry depends increasingly on catastrophe loss models for pricing, capital assessment, and management. In the twenty or so years since they first appeared, our businesses have become increasingly reliant upon these models and, as Hemant Shah said in a recent article:

"Somewhere along the way, appreciation for the inherent uncertainty in risk has been diminished or even lost." (1)

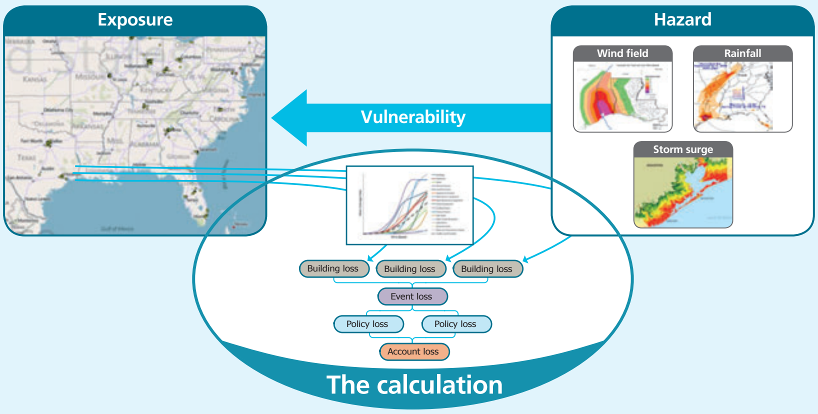
Meanwhile, as our dependency has grown, the world around us has changed. Regulators have started demanding that we explain our understanding of models and limitations rather than delegating that job to loss modelling companies or brokers. A wide range of hazard and vulnerability models from sources other than the three main loss modelling companies is now available, many covering previously un-modelled perils and territories. Best of all for those who use them, new technologies make it possible to compute the numbers much faster, allowing bigger portfolio models, greater granularity of calculation, and the ability to test assumptions.

In this article Peter Taylor of the Oasis Loss Modelling Framework discusses how Oasis, a not-for-profit initiative for open source Cat modelling software, supports this transition to fast, open and transparent modelling, which he argues will lead in time to a broad consumer marketplace for risk models and "Cat modelling for the masses".

The evolution of catastrophe loss modelling

Years ago, we assessed exposure to catastrophes using crude measures of exposed values ("aggregates", sometimes risk-weighted as "PMLs") and premium market share, to give a feel for relative exposures. We knew very little about the detail and indeed the level of risk involved. Without statistics, we were flying blind. This all changed around 20 years ago when Karen Clark – Expert in catastrophe risk assessment and management – saw that a more granular approach to estimating catastrophe losses was possible, as illustrated in the Figure 1.

Figure 1: **General schema of assessment of exposures to Nat Cat**



(1) *Hemant Shah "A Paradigm Shift" in the CEO Risk Forum 2012.*

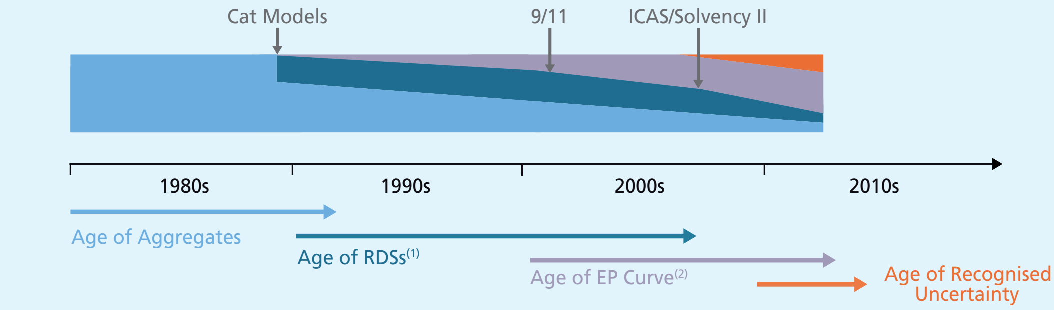
The radical insight was that with information about properties, catastrophe events and how the property types responded to event intensities, one could construct a ground-up model of loss and then apply policy terms and conditions to estimate the insurance loss.

Computers were able to undertake the iterative calculation based on individual ("deterministic") events and on catalogues of events representing all possible events and their frequencies ("probabilistic"). Lloyd's introduced "Realistic Disaster Scenarios" (RDSs) as deterministic probe tests of underwriters' books of business. And then (especially in London) the crisis of 9/11 moved us to full regular probabilistic modelling for exposure and pricing. We entered the "Age of the EP Curve", the "EP" being Exceedance Probability (also called Value at Risk), which is essentially the probability distribution of annual loss.

Since then, regulators have gone much further and with Individual Capital Adequacy Standards – ICAS – (in the UK) and Solvency II (EU-wide) introduced a 99.5% annual loss threshold for capital adequacy, sometimes referred to as "1 in 200 year VaR". This means that the regulatory capital requirement is set as no less than the point on the annual loss EP curve beyond which there is only a 0.5% probability of occurrence in any one year. All praise to the EP Curve!

Where we now find ourselves, though, is in a world beyond the EP Curve as it has become clear that the EP Curve is a simplification which disguises uncertainties in terms of what we know about risk. It is convenient, but idealised, and a truer understanding of risk needs to tackle the underlying uncertainties. That is why the Figure 2 below, which summarises this timeline, shows us leaving the "Age of the EP Curve" and entering the "Age of Recognised Uncertainty".

Figure 2: **The four ages of Cat modelling**



(1) Realistic Disaster Scenarios
(2) Exceedance Probability

RATIONALE FOR OASIS

For many years, there had been mutterings in favour of "open source" modelling, but in practice there was little appetite for this as we all got used to running the commercial loss models and their new "riches" of information. It also seemed pretty pointless when they appeared to command such depth of research and IT capability. Why do a half-baked job with some open source computer code no-one was ever likely to use? It was almost like saying business people wouldn't use Microsoft Office. Heresy!

What has happened in the past three years, whether due to regulator demands, model version impacts, losses from un-modelled territories/perils, or just general concern at the cost of Cat modelling, is an undercurrent of interest in seeing what could be done that would bring more model providers to the table, offer greater transparency and rigour, and take advantage of the new computer technologies for calculations and presentation. It is in this context that Oasis was born.

Founded in London with directors from Lloyd's, the UK Knowledge Transfer Network, the EU Climate KIC, and industry representatives, Oasis has set out on an ambitious delivery-driven programme to design and build a new open (free to all to use) loss modelling solution by the end of 2013. And as we write this article (October 2012) we are ahead of schedule.

KEY ISSUES

When you dig beneath the simple exterior of loss modelling, there are some tough issues to tackle if the models are going to be practical rather than theoretical tools. In the hazard modelling field there are questions of event definition and synthetic event set generation; in vulnerability modelling, there are questions over the basis of fragility/damageability curves; moreover there are open questions over handling multiple perils and multiple models. Above all we need to ensure that hazard, vulnerability, and exposure data are consistent and have some basis for validity.

On what grounds can it be argued that an event set is realistic, or that an associated damageability function reflects actual losses? Most of all, how do we deal with the many sources of uncertainty in terms of producing numbers on which we can base decisions?

It is often argued that models incorporate "the best science", yet we have seen again and again in the past ten years, and recently with Tohoku, that the role of "best science" is to inform our choices, not make them for us. These models are inherently imperfect and we must take our own views of risk.

The Oasis vision

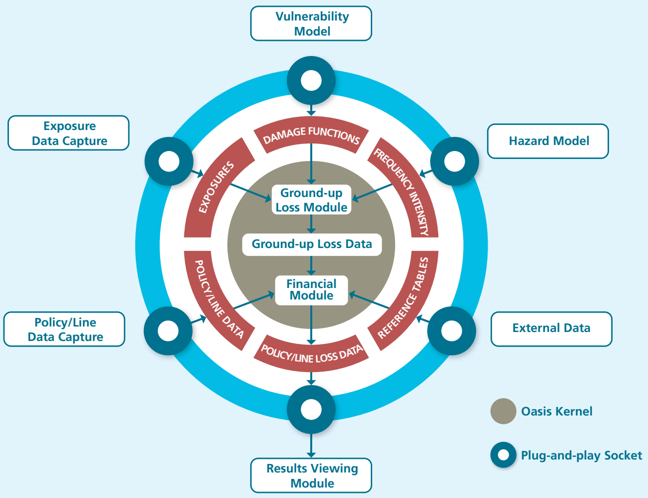
Oasis has four key differentiators that will, we believe, transform the way in which catastrophe loss modelling is conceived and operated. They are:

- **Transparency**, not just in "open source" code but in the way in which the assumptions of models are made clear and tested.
- **Community**, so that the industry and providers of models and services come together under the "open" banner to create a central public good (the Oasis open source programs, data standards and methods) and new relationships.
- **Innovation**, in the way loss models are architected, how calculations are made, and how computer technology can assist in the new expressions of uncertainty.
- **Delivery**, working on "seeing is believing" with real problems, and developing an "e-marketplace" so that the commercial buyers and sellers of models, data, runtime, and consulting services can prosper to their mutual benefit.

TRANSPARENCY

Oasis offers a "plug and play" architecture as the method by which the real providers of knowledge – the modellers – and the real users – those with exposure and policy data, can interact in an open source solution which removes the current proprietary restrictions, as illustrated in the Figure 3.

Figure 3: **The Oasis loss modelling framework**



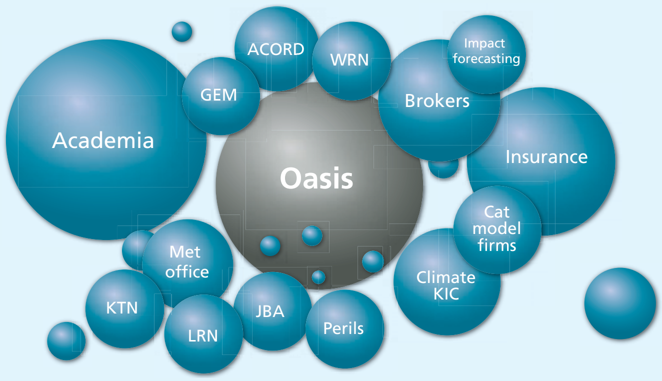
Transparency is not just about the architecture, though, it is also crucially about the assumptions in the models and how users of the risk models can assess the sensitivity of their results to these assumptions. The sorts of questions Oasis will facilitate include:

- How were the event sets constructed?
- Do you address the open scientific questions in this area?
- How was damageability determined?
- What validation was performed?
- How sensitive are results to exposure data characteristics?
- How many samples and how many years simulation to get robust results at 1 in 200 years?
- Can the uncertainty be seen in the results?
- Are all the calculations auditable and repeatable?

COMMUNITY

The central strength of Oasis is that it represents a community of common interest within the insurance industry and with suppliers of models and services to the industry, as illustrated in the Oasis "eco system" diagram below:

Figure 4: **The Oasis community of common interest**



Industry Members include Lloyd's, SCOR, Aspen Re, Catlin, Validus, Partner Re, Renaissance Re, Hiscox. Tiger Partners, AonBenfield, Guy Carpenter and Willis, amongst others.

Oasis has raised € 4 million from EU ClimateKIC and expects € 1-1.2 million from Insurance Industry Members.

Associate Members include the EU ClimateKIC, Karen Clark & Company, the UK Met Office, JBA, ImageCat, Cat Risk, Perils, Colt, Spatial Key, KatRisk and Maxeler, amongst many others.

INNOVATION

Oasis brings many innovative ideas to catastrophe loss modelling, including:

- Oasis will publish Model Development "Good Practice" guidelines to help model developers.
- Oasis will create a new library of insurance policy structure and calculations, which can be invoked in the "financial module".
- Oasis has already defined a new "sparse data" method to provide only the essential and anonymous data from "client" users to "server" calculators, which allows massive data transfer volumes, anonymity, and faster calculation within the Oasis Kernel.
- On the output side, Oasis is promoting new visualisations of risk, including uncertainty, suitable for non-technical as well as technical people.

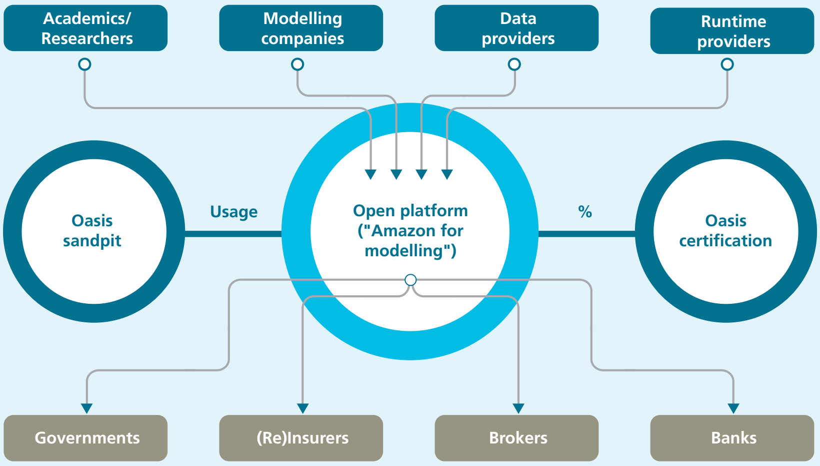
DELIVERY

Oasis adopts a "show me" approach with real portfolios and models so that these can be tried by users and we can all learn from this in fast order. The Timeline is:

- Phase 1 **Prototype** based on existing proven Cat model to demonstrate "plug and play" and technical performance: January – June 2012.
- Phase 2 **Proof of Concept** delivers 4 Cat models to sponsoring community: July – December 2012.
- Phase 3 **Build and Test** prior to first "Open" release: 2013.

As well as producing the computer solution, Oasis also sees as essential an ongoing vibrant marketplace of models and data within the open framework – an "e-Marketplace" as illustrated below:

Figure 5: **Oasis: an "e-Marketplace"provider**



Establishing this so that it can be self-perpetuating is the biggest challenge facing Oasis in 2013 and 2014.

In conclusion, a summary reminder of what Oasis is and what it is not.

Oasis is

- Not for profit
- Open
- A simulation framework
- A community
- A delivery model
- A development environment
- An accreditor

Oasis is not

- For profit
- Secretive
- A Cat model
- An e-marketplace provider
- A runtime environment
- A standards body

5

SCOR
PLATFORM INITIATIVES

JAKIR PATEL
Senior Cat Risk Portfolio Manager
SCOR Global P&C SE

Over the last 20 years, catastrophe models have been implemented in the (re)insurance industry and are now essential tools facilitating a number of key functions, including pricing, accumulations, capital adequacy, profitability measurement, regulatory compliance and rating agency reporting. However, off-the-shelf catastrophe model software has not evolved in step with business needs over this period, leading to shortfalls in many areas. This has created operational challenges that companies try to address by developing suites of bespoke and often very complex "model interfacing tools", to meet the growing demands of both internal and external stakeholders.

Extraneous drivers such as Solvency II and rating agencies' requirements have certainly added to the need for real-time business analytics and intelligible information feedback loops. Incorporating Cat risk robustly into the ERM, Pillar 1 and ORSA [1] frameworks requires considerable technology capabilities, as well as access to the right expertise, credible sensitivity analysis and "what-if" testing, plus an understanding of model uncertainty, for example via multi-modelling approaches.

Recognising these operational challenges, SCOR has initiated a number of strategic technology projects, which include developing a state-of-the-art Cat modelling platform (Cat Platform) in partnership with RMS, and investing in a new cutting-edge facultative underwriting platform (Fac Platform). Both the Cat Platform and Fac Platform are expected to deliver unparalleled, scalable and agile analytical capability across the organisation far beyond the conventional limitations of technology – creating business value that is not easy to achieve in the current climate.

This article will explore the evolving nature of risk management, the concept of platforms and the motivations and challenges involved in the development of such technology from a reinsurer's perspective, as well as the value that these initiatives are expected to bring to SCOR and its clients.

Evolving risk management landscape

(Re)insurance companies may increasingly be viewed as analytical enterprises – the industry as a whole has evolved tremendously in this regard over the last two decades. However, there are still broad differences in the analytical capabilities of (re)insurers, especially when it comes to pricing and managing catastrophe risk, while facultative business presents additional and unique challenges.

The competitiveness of (re)insurers is often supported by extensive in-house technology and analytical capability, designed to support the business decision-making processes. The standard of this technology differentiates one (re)insurer from another.

(1) Own Risk and Solvency Assessment.

Regulatory compliance adds a further dimension to this, because increased scrutiny from regulators and rating agencies, along with Solvency II requirements, mean that (re)insurance companies are facing an increasing number of constraints, and competing demands from both internal and external stakeholders. This furthers the need for companies to considerably upscale their analytical capabilities. As the risk management framework increases in complexity and ambition, so do the underlying standard business processes, such as performing real-time accumulations, model change management and multi-model blending, all set against a backdrop of ever-increasing data volumes and increasingly complex models. All of these drivers make the case for investing in capabilities and technologies today in order to support business processes that will be fit for tomorrow.

Platform as a technology

A platform should not be confused with the standard software that sits on the periphery of core business processes, or be regarded as a piece of "bolt-on" software that is simply used to run calculations or generate reports. A well-designed and successfully deployed platform should be efficiently integrated into existing systems and complement key business processes, whilst being resilient, agile, highly available and, of course, secure.

A platform can therefore be simply defined as a place to "launch" application software. It may include some baseline operational hardware and software, but ultimately it is general and adaptable and provides a particular way of abstracting and organising components of data. A successful (re)insurance platform should be an agile and scalable business "eco-system" and should, amongst other things:

- Include a comprehensive toolkit that enables robust execution and the reduction of unnecessary "model-ware" clutter;
- Be designed to go beyond the conventional limits of modelling by leveraging advances in analytical and technical computing capability;
- Be able to drive out manual and repetitive processes that don't add value;
- Create integration and automation points with other business workflows (claims, contract management and other modelling and risk assessment tools) to aid decisions;
- Be readily extendible to new business processes and analytics;
- Improve risk quantification through risk intelligence (e.g. exploring uncertainties/sensitivities);
- Facilitate the generation and deployment of internal risk views, including the interoperability, blending and calibration of multiple model sources.

The Cat Platform

THE ACCIDENTAL CAT MODELLING "ECO-SYSTEM"

Off-the-shelf Cat models have become firmly embedded within (re)insurance organisations and have provided incredible value over the last two decades by enabling companies to assess risks using the latest risk quantification methods and tools for natural and man-made disasters. This has no doubt increased discipline across the risk transfer chain through the "currency" of Cat model outputs. However, out-of-the-box catastrophe model software solutions have invariably fallen short when it comes to the delivery of tools that meet current and ever-evolving business and regulatory requirements. Operational headaches are common amongst Cat model users and often relate to poor performance and model execution capability, model legacy and stability, limited access to data for downstream tasks, poor data mining and reporting capability, limited integration capability, unrepresentative financial modelling features, un-modelled perils and so on and so forth.

This inflexibility, incompleteness and limited functional scope have led many end users to develop libraries of bespoke and often very complex "model interfacing tools" over a number of years, with varying degrees of success. This inevitably creates a huge amount of overhead and process/person risk for companies, as they constantly struggle for resources to adapt and develop bespoke "model-ware" to yet another model version release, or to fill gaps in functionality.

Moreover, given the trend towards increasingly complex models using progressively granular data and corresponding analyses, the need for real-time business analytics, information feedback loops, additional sensitivity and what-if testing, and the desire to understand model uncertainty through multi-modelling approaches, the stakes are now being raised at all levels. This includes the provision of suitable technology hardware to support the modelling process.

Whilst the *ad-hoc* approach of filling functionality gaps in the models has so far alleviated some short-term, common business needs for many model practitioners, a saturation point has been reached in many organisations and these "accidental modelling eco-systems" are unsustainable going forward. In many respects, the approach does not add sufficient value to front-line business processes, nor does it necessarily help to meet business objectives around enterprise risk management or to accommodate additional analytical needs without disruption – this was part of the motivation behind the decision to embark on the development of the Cat Platform.

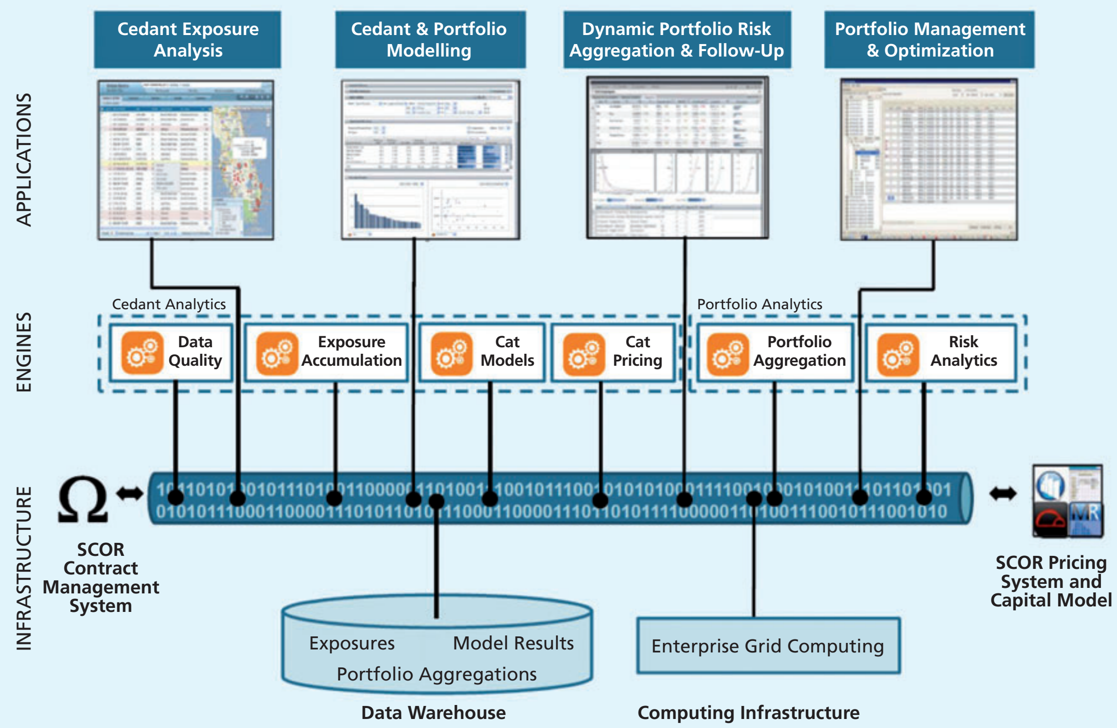
DEVELOPMENT OF THE CAT PLATFORM

SCOR started the Cat Platform initiative late 2010, in partnership with RMS. The key business objective of this platform was to lead the reinsurance market in terms of expertise and capability by building a state-of-the-art analytical framework that defines a new standard for the future. The need for a centralised platform, integrated in real-time with other systems such as the Contract Management, Pricing and Capital Model, was recognised from the outset. The framework was further designed to increase operational efficiency by driving out manual and repetitive processes wherever possible.

The target Cat Platform covers four analytical drivers of Cat business (see Figure 1), as summarised below:

- "Cedant Exposure Analysis" is the starting point of the underwriting process and enables the visualisation and validation of the underlying exposures;
- "Cedant & Portfolio Modelling" addresses the challenge of modelling the cedant's catastrophe risk and dynamically integrating the results into the extant portfolio so that the marginal risk impact and any correlations can be measured correctly;
- "Dynamic Portfolio Risk Aggregation & Follow-up" facilitates aggregation at portfolio/group level, including dynamic follow-up of the company's aggregations as the renewal phase progresses throughout the year;
- "Portfolio Management & Optimization" facilitates the development of a more effective portfolio management strategy, enabling optimum utilisation of capacity by incorporating the diversification effects of writing both catastrophe and non-catastrophe business in different geographical areas, whilst using retrocession planning to reflect target net risk tolerances.

Figure 1: **Cat Platform framework features**



Another important feature of the Cat Platform is that it is fully integrated with other SCOR information systems such as our Contract Management System, Pricing System and Capital Model, in one coherent block. This live integration means that the business data and processes can be fully aligned at all times, hence guaranteeing data integrity.

The underlying exposures and modelling results for each contract are captured within the data warehouse along with a history of the portfolio aggregation runs.

On the infrastructure side, the Cat Platform deploys Enterprise Grid Computing (EGC) technology – regarded as "supercomputing" capability for catastrophe modelling – which provides the business with huge levels of flexibility and access to scalable computing resources on demand. The Cat Platform is a multi-year initiative in which additional features are continuously being developed and dropped into the production setting in order to increase the value proposition over time. An early version of the Cat Platform is already in production use within SCOR today.

The Fac Platform

The Fac Platform was initiated in early 2011 and is being designed to specifically handle SCOR's business written on a Facultative basis, including large and complex risks that typically do not fit into standard reinsurance treaties. These risks are often global in scope and offer broad coverage beyond conventional catastrophes. The services provided to corporate clients and producers are equally diverse as shown in Figure 2.

The goal of the Fac Platform initiative was to develop a technology framework to drive "best practice" underwriting through greatly enhanced quality and consistency of data and pricing methodologies. This would be supported by improved user interfaces and data display, enabling better risk analysis and underwriting decisions, supplemented by a suite of highly efficient contract monitoring and reporting modules.

Figure 2: **Fac Platform – SCOR Business Solutions**

Large corporate risks

ENERGY & NATURAL RESOURCES

Energy, Power and Mining
- Refining & Petrochemicals
- Gas and LNG
- Chemicals
- Power and Utilities, Renewable Energies
- Mining

Offshore & Shipbuilding
- Exploration & Production
- Offshore Contractors
- Shipbuilding

INDUSTRIAL & COMMERCIAL RISKS

Manufacturing & Heavy Industries
- Automotive, Mechanical Industries
- Metals processing
- Pulp & Paper, Cement
- Aeronautics/Defence
- High Tech
- Life Sciences

Infrastructures & Services
- Transportation
- Environmental Industries
- Telecom & Media
- Professional Services, Engineering firms, General Contractors
- Retail & Trading

A consistant offering from initial risk analysis to claims handling, including risk management

TECHNICAL RISK ANALYSIS,
risk prevention and risk control surveys, technical seminars

UNDERWRITING CAPACITY AND TAILOR-MADE SOLUTIONS:
ability to design, quote and lead (re)insurance programs for all major lines of business, on both a Quota Share and Excess of Loss basis, as a direct insurer or as a facultative reinsurer

HANDLING OF LARGE AND COMPLEX CLAIMS,
and timely delivery of claims services

SCOR Business Solutions Key Figures

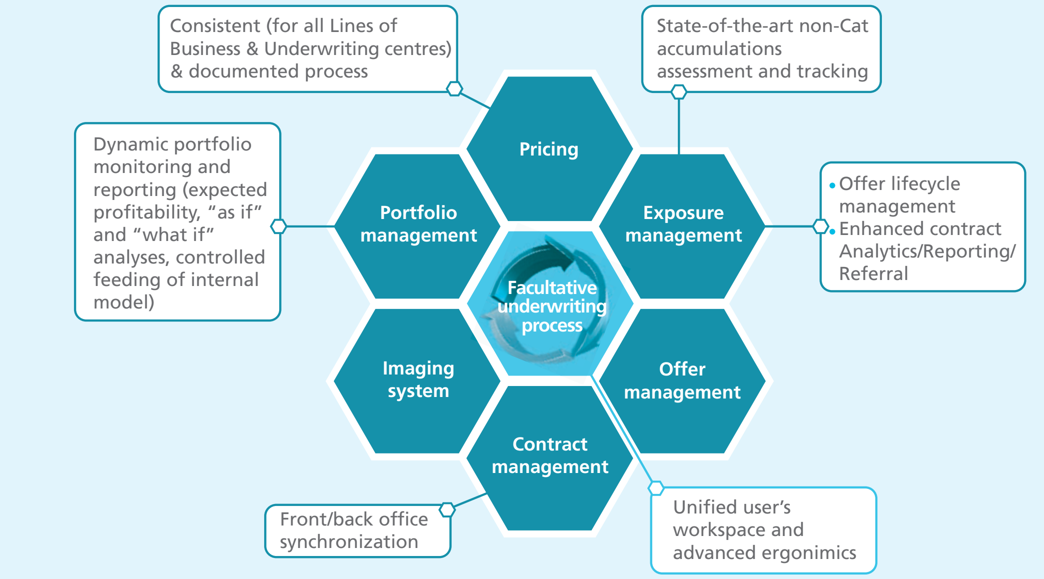
15% of SCOR Global P&C portfolio

70 specialised Underwriters

12 Underwriting or Marketing centres

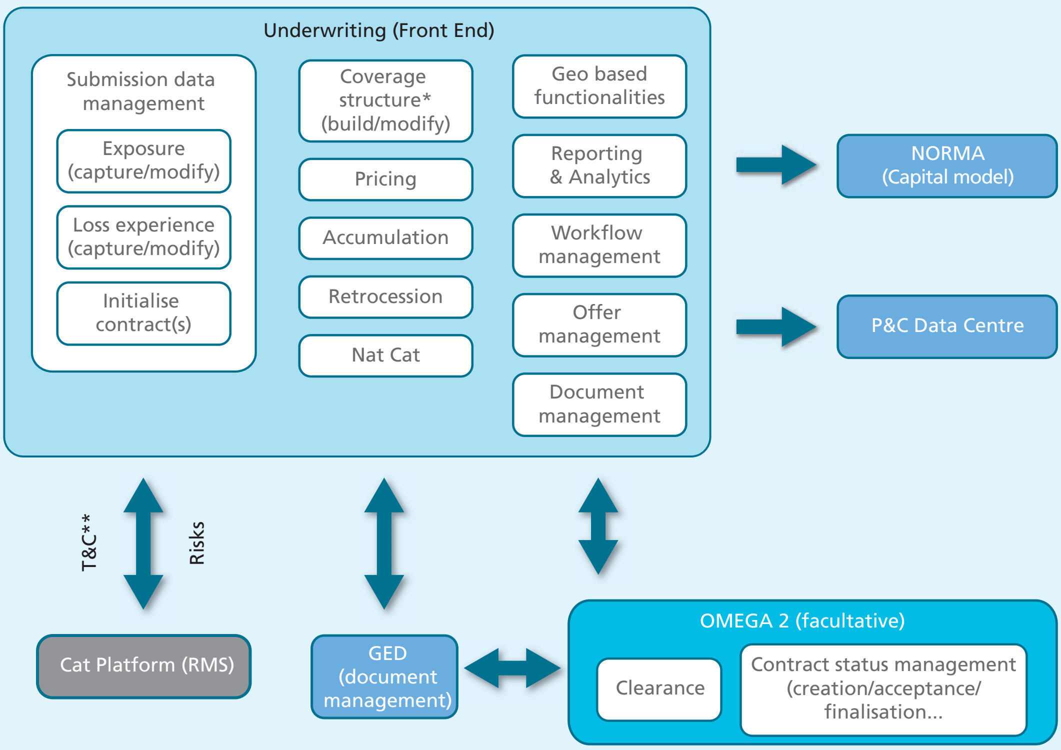
The key strategic objectives of the Fac Platform were to create a framework to develop existing classes and to explore new business segments, whilst actively managing market cycles by business segment. Dynamic operational profitability monitoring, in terms of each contract and the portfolio as a whole, is also required so that resources such as capital, catastrophe capacity, retrocession efficacy, etc. can be fully optimised. The objectives of the Fac Platform can only be met with an integrated system that supports all the key elements of the underwriting process, as shown in Figure 3.

Figure 3: **Fac Platform integrated system features, value proposition and objectives**



The Fac Platform further supports the ERM framework and external auditors' and regulators' requirements (including meeting obligations under Solvency II), for which it is crucial to have practical evidence that structured, documented and controllable pricing and accumulation processes are in place and are being followed. As with the Cat Platform initiative, it is crucial for the Fac Platform to interoperate efficiently and in a controlled way with other internal IT systems, such as Omega (Contract Management), NORMA (Capital Model) and the Cat Platform itself. A high level view of the target unified front end system and functional architecture, including the crucial integration points, is shown in Figure 4 below.

Figure 4: **Fac Platform – SCOR Business Solutions**



** Structure included Cat and non-Cat T&C*
*** T&C: Terms & Conditions*

Value dimension of the SCOR platform initiatives

The value dimension of both the Cat Platform and the Fac Platform is significant and SCOR is already seeing tangible benefits from the early iterations of these new technology frameworks. Some of the key strategic benefits of the initiatives for SCOR are summarised below:

- More **efficient capital utilization** and increased Return On Equity (ROE) with real-time "coherent" business intelligence – this is instrumental in terms of further developing franchise brand and value;
- More **accurate catastrophe risk control** relative to the available or assigned risk capital, this is achieved via dynamic accumulations and through the delivery of timely, actionable information to underwriters and management with regard to underwriting decisions;
- **Improved risk selection and increased profitability**, this is achieved through the Cat Platform's robust capabilities in terms of differentiating cedant portfolios, analysing sensitivity to data quality, testing model uncertainty by taking control of key assumptions during pricing and the accumulation management process. The scaling up from a cedant to portfolio-level view is crucial in terms of running an ultimately successful Cat risk management function;
- Enabling achievement of **strategic growth objectives** by actively managing risk exposure aggregations across the globe in real-time and checking for correlations and diversification benefits and constantly measuring these against capital targets.
- Fully leveraging the benefits of a **robust centralised analytical infrastructure** to create a new benchmark in analytical capability, through a high degree of automation and scalability leading to increased operational efficiency and the elimination of redundant data entry and latency.

Most importantly, the SCOR platform initiative will bring benefits to our clients over time, as summarised below:

- Support for the **Cedant Facultative Services** underwriting operation through the rapid and robust capabilities of the Platforms to differentiate cedant portfolios and check sensitivity to data quality and model uncertainty;
- Increased responsiveness to our clients by **providing meaningful solutions** that are both quantifiable and qualitative, through dynamic accumulations and pricing studies using the integrated framework of the Cat and Fac Platforms;
- Actively dealing with **specialised risk capacity** requests by rapidly assessing against Group capacity metrics, through capacity management feedback loops from the Cat Platform;
- Giving **analytical depth and rigour** to the judgments that we make during the underwriting and risk management processes;
- Sharing our findings, taking on board the **expertise of our cedants** and integrating these into the overall underwriting risk assessment strategy;
- Creating a unified but **comprehensive technical standard** for risk assessment to allow us to address the coverage needs of our cedants consistently, by increasing visibility to business intelligence data and metrics in real time;
- Adding value to the **post-event loss assessment** process by giving visibility to exposure and loss accumulations through readily accessible business intelligence data available in both the Cat and Fac Platforms.

Summary

The SCOR platform initiatives are multi-year endeavours and the operational benefits of investing in these cutting-edge technological frameworks now are significant, since they create an environment that greatly increases operational efficiency, directly adding value to many core business processes and supporting the overall business strategy of creating an out-performing portfolio that effectively services our clients and other key stakeholders.

The need for investment in technology and analytical resources within (re)insurance companies is set to continue for some time, as new solvency and underwriting control regimes come in to force. SCOR is well placed to meet this need in good time.

6

US TORNADOES

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The 2011 tornado season was the costliest on record, with US$ 25.8 billion losses contributed by 23 events as recorded by the Property Claims Services (PCS). To date, the 2012 season is active, but less so, with losses to May standing at US$ 6.1 billion. The heavy losses from the 2011 season have brought this peril into focus; layers which had been designed for hurricane losses were affected by what had previously been considered only a "frequency" peril, reiterating that the localised severity of this peril can be significant, especially for regional programmes.

The severe thunderstorm, or severe convective storm, peril is, according to the National Weather Service, a combination of three sub-perils: tornado, hail and straight-line winds. These sub-perils cause different types of damage from wind and hail. The most extreme, EF5 tornadoes are defined by "slabbing" where only the foundation of the building remains. In tornadoes, building collapse is generally due to internal pressurisation when the envelope is breached during intense winds (via garage doors, windows, doors) and it is these scenes of total devastation which often make the headlines. The debris is lifted and forms missiles leading to "cones of damage" around the track of the tornado. The straight line winds associated with severe thunderstorms are more moderate, although gusts can be very damaging: gusts have been recorded equivalent to windspeeds of a Cat 4 hurricane. Hail damage depends on the size and speed of the falling hail, but damage to roofs, shutters and windows is common. Hail damage is particular issue for auto, where salvage becomes less economic.

As well as having distinct damage types, there are variations in loss detection periods and claims: tornado damage is usually detected immediately, but for hail, property claims can take a while to be reported. Damage may take a while to become apparent, for example with holiday homes will only be detected when the owner returns to the property and discovers that the inside is wet.

The geographical distribution of the perils is also different, as the analysis of data from the National Severe Storms Laboratory shows in Figure 1 below.

Figure 1: **Density of tornado, hail and straight line wind events**

Tornado — Hail — Straight line winds

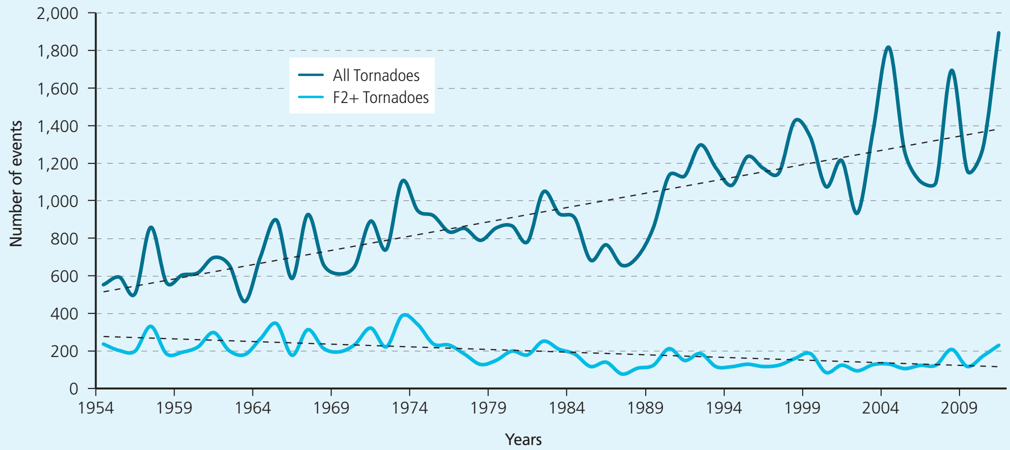
Given the unusual losses seen last year, there has been much discussion of whether the 2011 season was an anomaly or whether this is a new, more active, regime for the peril. This paper describes analysis that SCOR have undertaken to better understand the peril and the tools available for modelling it.

A trend in the hazard?

Unfortunately, there are a number of issues in trying to understand history when considering the hazard. Straight-line winds were only identified as an area of research in the 1980's and it is probably that the damage was misclassified before this. Hailstorms can be very hard to detect when they occur over rural areas.

Tornadoes are the best recorded of the perils and therefore provide the best insight. Considering Figure 2 below, a marked increase in the number of reported tornadoes is obvious.
However, the tornado record itself is subject to changes in reporting behaviour since the 1950s including increased public awareness, introduction of the use of Doppler radar and more population observing the events.

Figure 2: **Tornado frequency since the 1950s**



Source: Storm Prediction Center

When only stronger tornadoes (F2+) are considered, the trend disappears; this situation is more likely to be representative of the real trend since these more violent tornadoes will always have been observed and will therefore not be subject to the observation biases affecting weaker tornadoes.

Figure 3: **Tornado scale and inferred windspeed**
(from http://www.spc.noaa.gov/efscale/ef-scale.html)

Fujita scale			Derived EF scale		Operational EF scale	
F Number	Fastest 1/4-mile (mph)	3 Second Gust (mph)	EF Number	3 Second Gust (mph)	EF Number	3 Second Gust (mph)
0	40-72	45-78	0	65-85	0	65-85
1	73-112	79-117	1	86-109	1	86-110
2	113-157	118-161	2	110-137	2	111-135
3	158-207	162-209	3	138-167	3	136-165
4	208-260	210-261	4	168-199	4	166-200
5	261-318	262-317	5	200-234	5	Over 200

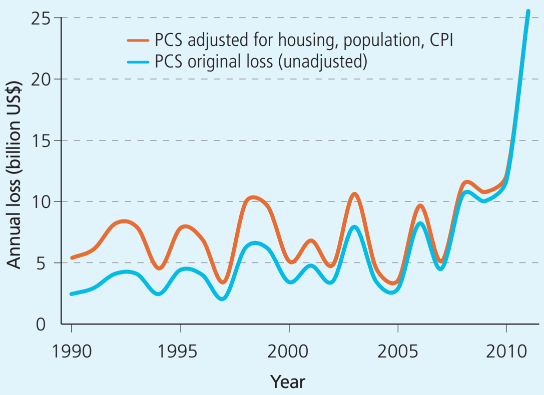
It is worth noting that the classification of tornadoes also changed in 2007, moving from the Fujita (F) to Enhanced Fujita (EF scale) and that tornadoes are defined in terms of damage, not windspeed (Figure 3).

This analysis shows that the issues with the hazard data make it very difficult for us to conclude anything about the trend of the frequency of the events themselves.

A trend in the losses?

Given the issues around the hazard information, we can also look at the losses, as after all, it is the losses which are of concern to us i.e. the product of the exposure, hazard, vulnerability and financial conditions. In the US, Property Claims Services (PCS) maintains a database of property catastrophe loss estimates. Although this database is not fully complete for the market (not all companies participate and a catastrophe loss must exceed the US$ 25 million threshold to be included), it provides insight to the industry losses.

Figure 4: **Tornado-hail losses from PCS since the 1950s**



Source: PCS

In Figure 4 we see both the annual reported losses since 1990 and the losses indexed for housing, population and consumer price index. In both cases, an upward trend is clear. We also have an in-house indexation which attempts to capture changes in insurance conditions and using that we still see a trend. In fact, indexing for everything we have available, an upward trend in losses remains since 1990. The reason for this remaining trend is not known but we suspect that given the very small spatial scale of tornadoes increasing downtown sprawl in the last decades may mean that there is more area for the tornadoes to hit. We have begun some analysis of historical satellite imagery to see if we can derive an index to describe this that we can use to explain some of the trend.

A connection with the global climate?

The relationship between tornado activity and large scale weather phenomena, such as El Niño-Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) has been the subject of increased discussion.

A brief description of these two climate indices is given below and they are illustrated in Figure 5. The Pacific Decadal Oscillation (PDO) is a recently described pattern of climate variation similar to ENSO, which is characterized by Sea Surface Temperature (SST) anomalies of one sign in the central North-Pacific and Sea Surface Temperature (SST) anomalies of another sign along the west coast of the Americas. The oscillation primarily affects weather patterns and sea surface temperatures in the Pacific Basin and North America. PDO eras persist for decades (20-30 years). The ENSO (El Niño-Southern Oscillation) cycle includes La Niña and El Niño phases as well as neutral phase. El Niño (La Niña) is a periodic warming (cooling) of surface ocean waters in the eastern tropical Pacific which causes a shift in convection in the western Pacific further east (west) than climatological average. These conditions affect weather patterns around the world. El Niño periods occur roughly every four-to-five years and can last up to 12 to 18 months. ENSO is measured in different ways, including the SOI (Southern Oscillation Index) based on (atmospheric) pressure difference between Tahiti and Darwin, Australia. This is highly correlated with tropical SST anomaly indices recorded in El Niño 3, which we have used for the analysis.

Figure 5: **Sea surface temperature (shaded) and surface wind stress (arrows) anomalies for positive (warm) and negative (cool) phases of the El Niño-Southern Oscillation and Pacific Decadal Oscillation**

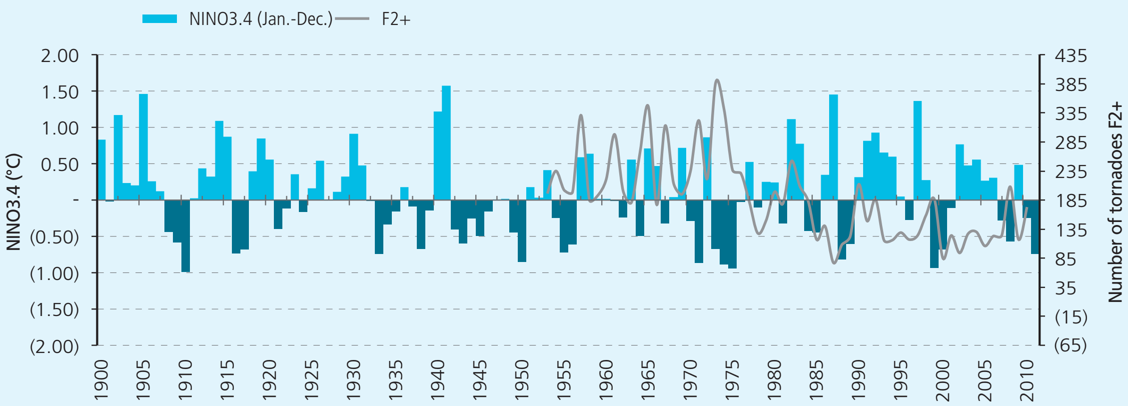
Pacific Decadal Oscillation — Positive phase, Negative phase

El Niño-Southern Oscillation — El Niño, La Niña

Source: Joint Institute for the Study of the Atmosphere and Ocean

There have been various studies looking at the relationship between tornado frequency and ENSO, some of which show a weak correlation with the number of tornadoes. For instance, Knowles and Pielke (2005) showed little difference in total number of tornadoes with ENSO phase, but La Niña increases number of violent tornado tracks, violent tornado track length and outbreaks containing more than 40 tornadoes. During El Niño there was shorter track length, fewer violent tornadoes and only slim possibility of an outbreak. A simple analysis does not reveal this (Figure 6).

Figure 6: **NINO3.4 index against tornado (F2+) frequency**

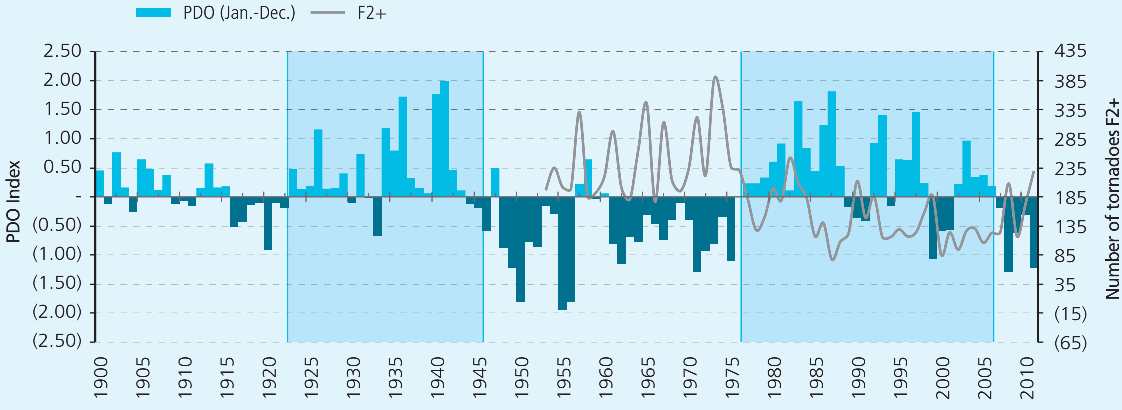


Source: http://iridl.ldeo.columbia.edu/

The relationship between tornadoes and the Pacific Decadal Oscillation (PDO) is more controversial and is currently a topic of discussion between scientists, some of whom dispute the existence of not only the connection, but the robustness of the PDO itself.

However, comparing the Jan-Dec PDO index to the annual number of F2+ tornadoes appears to show a relationship where the number of tornadoes increases in the cold phase of the PDO (Figure 7).

Figure 7: **PDO index against tornado (F2 +) frequency**



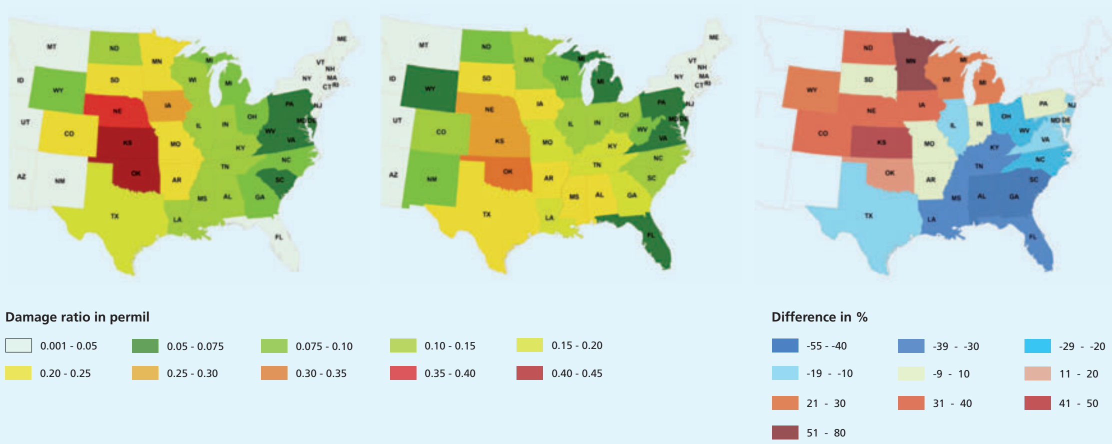
Source: http://jisao.washington.edu/pdo/PDO.latest

Modelling tools and pricing

A number of commercially available models exist in order to understand the probabilistic losses associated with severe thunderstorm. Of those that SCOR licenses, there are markedly different views of the risk, which varies significantly on a regional basis between models.

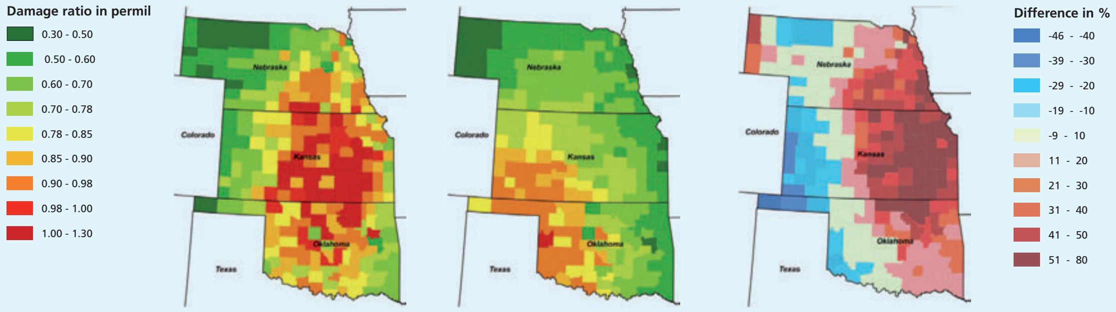
We can compare the annual mean loss damage ratio (annualised loss per unit exposure) from two of the commercial models at a state level. The models disagree in the absolute values of risk and in the regional pattern of the risk (Figure 8).

Figure 8: **Average annual loss per unit exposure for model A (left) and model B (right) Difference between model A and model B (far right)**



Even focussing on "Tornado Alley" where both models agree the risk is the highest, when we look at the risk on a county level (Figure 9), we see that there is very little consistency between the models and a great deal of "spottiness" between counties.

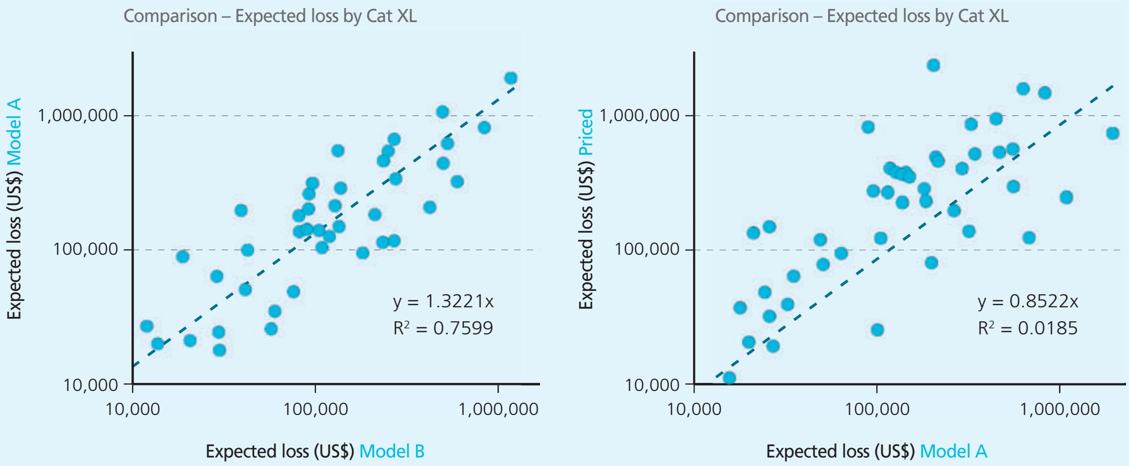
Figure 9: **Average annual loss per unit exposure for model A (left) and model B (right) Difference between model A and model B (far right)**



There is little cohesion between the models and a great deal of fine scale variability. The loss estimates will be very dependent on the exact geographic distribution of the exposure provided by the cedant.

We can also examine our pricing to see what happens to the expected loss to layers and how that varies with the model chosen. We see (Figure 10) that one model is systematically higher than the other, but the scatter is large. Further, we can compare what we actually used to price, which is often based on the cedant's experience and/or their estimated losses based on market share. In this case, we see almost no relationship between the expected losses to layer used in the final pricing and those calculated by the model. This shows that the existing models bear very little resemblance to our best view of the risk, taking all of the inputs we need for pricing.

Figure 10: **Expected loss to layer priced using model A and model B (left) Expected loss to layer finalised against model A (right)**

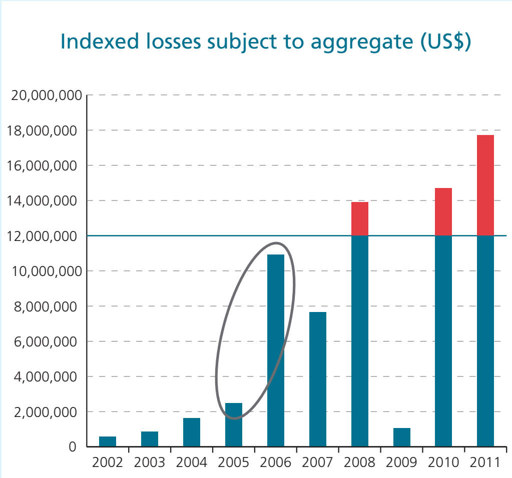


In examining all of the pricing that we have done, we also observed that reinsurance structures sensitive to loss frequency covering convective storm dominated portfolios typically show a remarkable increase in burning costs in the latter half of the ten year period 2002-2011. It may also be that the years before 2002 could have shown similar behaviour, but since individual cedant loss histories beyond 10 years are usually doubtful due to underlying changes in the portfolios and the market it is not possible to establish this for certain. This is illustrated below with a real cedant example (Figure 11). In this example, as in many others, we see a marked changed in the loss behaviour since 2006.

Figure 11: **Cedant loss history example**

Cedant historical losses indexed 2002-2011 (US$), *as if*

	Limit per occurrence 3,500,000	Annual aggregate limit 15,000,000
	Retention per occurrence 1,500,000	Annual aggregate retention 12,000,000
Year	Losses subject to annual aggregate cover	Annual aggregate loss
2002	583,246	0
2003	875,212	0
2004	1,623,054	0
2005	2,478,090	0
2006	10,933,150	0
2007	7,654,934	0
2008	13,912,296	1,912,296
2009	1,071,220	0
2010	14,700,400	2,700,400
2011	17,713,358	5,713,358
Grand Total	91,306,831	10,326,054



Cedant writing homeowners, farms, small commercial property in Midwest. Red color bar: Annual average loss covered (as if). Loss amounts include Hurricane Ike 2008 of 2 mio US$ subject to aggregate.

Considering that the phase of the PDO changed also in 2006, and that a relationship with tornado frequency has been postulated, it appears that this relationship requires more investigation. If the PDO is a factor in tornado frequency, then we could expect that the current increased loss frequency may continue. However, with the current data, we cannot say for certain. All we can say for certain is that we have seen an increase in losses: it may be due to climatic factors, or due to increasing area of exposure.

Conclusion

The 2011 season has reiterated that tornado peril is complex to model. Losses have been increasing. The reasons for this may be climatic or may be due to changes in the distribution of the exposure so that there is "more to hit". There is much discussion of whether we have entered a new more active phase for this peril and whether we can expect losses to continue to be high. We have no direct evidence for this, but the phase change of PDO and concomitant the increase in losses give pause for thought. The commercial tools available have differing views of the risk, are not adequate to price the risk and do not represent our best view. We continue to keep abreast of the scientific research, evaluate the models and are working with our clients to better understand, and develop appropriate strategies to manage this risk.

7

TSUNAMI RISK ASSESSMENT

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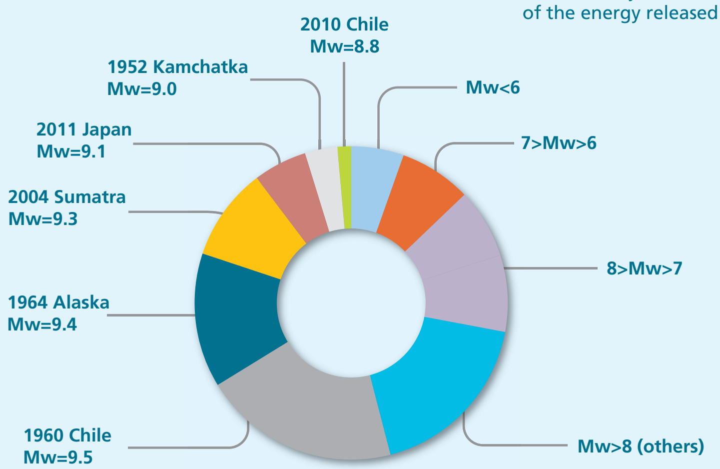
The high number of large earthquakes in recent years has fuelled concern that the global underlying rate of earthquake activity has increased, which would have significant implications for the assessment of seismic hazard and our understanding of how faults interact. The frequency of tsunamis as a powerful manifestation of the destructiveness of these large earthquakes has also shocked observers: since 2004, three global events in Sumatra, Chile and Japan, totalling US$ 280 billion in economic losses and resulting in 250,000 casualties, have impacted the insurance industry, the nuclear industry and car makers, and have also motivated political choices – new tsunami warning systems and tighter control of nuclear activity are two recent responses to the threat posed by tsunamis.

This article highlights the lessons that have been learned over the past few years and summarizes recent progress made in the Mediterranean region in terms of increasing the resilience of societies to tsunami risk. We also illustrate with some examples how the risk represented by tsunamis can be better handled by the insurance industry.

Figure 1: **106 years of moment release (1906-2011)**

It is striking that only 6 earthquakes over the last 106 years account for over half of the energy released during that time.



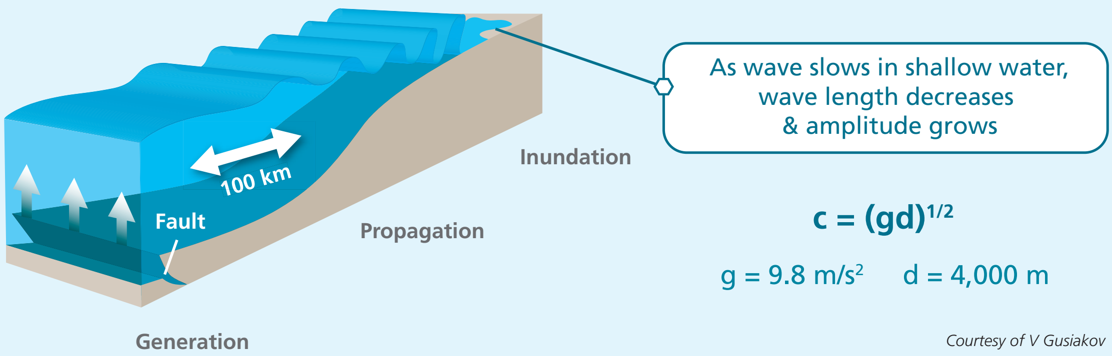
Source: IRIS, 2011

Tsunami phenomenology

A tsunami is a natural phenomenon consisting of a series of waves that are generated when a large volume of water in the sea, or in a lake, is rapidly displaced. Tsunamis are known for their capacity to violently inundate coastlines, causing devastating property damage, injuries, and loss of life. Tsunami modelling involves the simulation of three main phases: wave generation, wave propagation and inundation. Of these three phases, only the propagation phase can be accurately modelled and considered to be properly understood.

After the tsunami in Lais, Sumatra – Indonesia

Figure 2: **Description of a tsunami**



$$c = (gd)^{1/2}$$

$g = 9.8\ m/s^2$ $d = 4{,}000\ m$

Courtesy of V Gusiakov

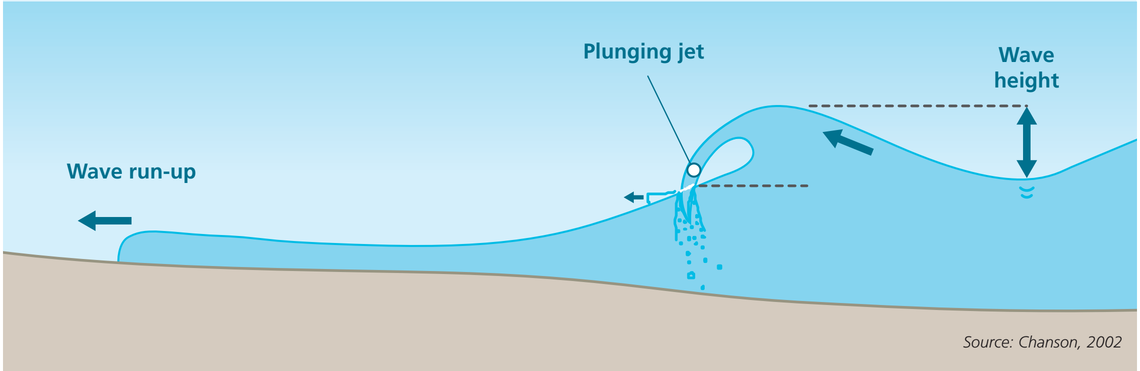
The first phase to be modelled is wave generation. The principal generators of tsunamis are:
- Large submarine or coastal earthquakes (in which significant vertical seafloor deformation occurs);
- Underwater landslides (often triggered by an earthquake);
- Large landslides from coastal (or lakeside) cliffs;
- Large underwater volcanic eruptions; and
- Meteor impacts in the ocean (very rare).

The two most common forms of tsunami generation are *coseismic displacement* (first bullet point above) and *mass failures* (second and third points above). Coseismic displacement occurs during most earthquakes and often generates tsunamis with longer wave lengths, longer periods, and a larger source area than those generated by mass failures, whereas mass failures produce tsunamis that attenuate more rapidly than those generated by submarine or coastal earthquakes. The risk represented by mass failures comes from their proximity to coastal areas. They are indeed usually triggered on the continental slope and may be several thousand meters high. They thus produce huge tsunamis that offer little warning due to their proximity to the shore.

The second phase, which involves the propagation of the tsunami in the open ocean, is well understood. The evolution of a tsunami wave is not influenced by the amplitude of the wave motion. In general, tsunami modelling is performed using linear long-wave equations. These linear models are capable of making highly useful leading-order assessments of tsunami propagation over ocean-basin scales, and their prediction of initial arrival time can be quite accurate.

The third phase, the inundation, is the most difficult feature of the dynamics of tsunami waves and deals with their breaking as they approach the shore. This phase depends greatly on the topography of the seabed (bathymetry) and on the coastline type. The breaking can be *progressive*, in which case the inundation process is relatively slow and can last for several minutes. It can also be *explosive* and lead to the formation of a plunging jet, as shown by the illustration 3 below. The impact on the coast is then very rapid.

Figure 3: **Evolution of a tsunami wave**



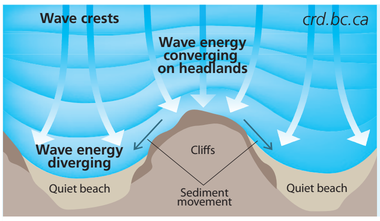
The trajectory and velocity of the inundation current are quite unpredictable, especially in the final stages, because they are sensitive to small changes in the topography of the flooded area, to the flow around the urban built environment, to the stochastic patterns of the collapse of buildings, and to the accumulation of debris such as trees, cars, logs and furniture.

The extent of the inundation, i.e. how far inland it reaches, depends on many factors:

- Distance of the shoreline from the tsunami-generating source;
- Magnitude (primarily related to earthquake source);
- Duration and periods of the waves;
- Run-up elevations (i.e. height above sea level likely to be flooded);
- Tide level at time of occurrence;
- Location along shore and direction of shore with respect to propagated waves;
- Topography of the seabed in the vicinity (bathymetry).

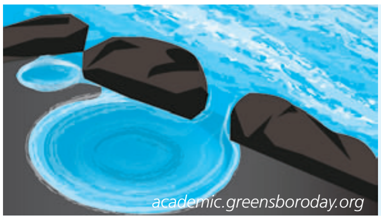
Clearly, a high-cliff coastline would be likely to experience no damage from a tsunami, while a low elevation shoreline would be easily overrun. Variations in wave characteristics can appear over very short distances along the coast due to differences in local refraction, diffraction (e.g. around offshore islands), and shoaling as explained on page 43.

For example in December 2004, plunging waves of between 4 and 6 metres were experienced on Phuket Island in Thailand, while 65 km away to the north, in Khao Lak, a moving wall of water came ashore with a height of over 11 m.



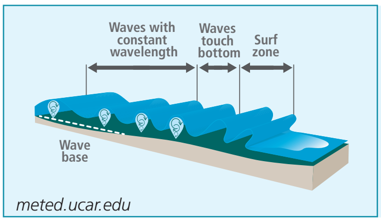
Refraction phenomenon

Refraction causes waves to converge at convex points such as headlands, where the increased energy causes erosion. Conversely, divergence and deposition of sediment occur at concave areas such as coves. This process is responsible for the formation of pocket beaches.



Diffraction phenomenon

Diffraction happens with all kinds of waves, including ocean waves, sound and light. Here's an aerial photo of ocean waves diffracting as they pass through a gap in a causeway.



Shoaling effect

As a wave shoals, the speed, height, and wavelength change. Water depths interfere with the particle movement at the base of the wave, slowing forward motion. As one wave is slowed, the following waveform which is still moving at an unaffected speed, tends to "catch up" with the wave being slowed. Wave height increases and the crests become narrow and pointed, while the troughs become wide curves. The trough between waves is flattened, and the crest sharpened. When wave height is approximately equal to water depth, the wave breaks.

Recent lessons

EARTHQUAKES AND TSUNAMIS IN FIGURES

On Sunday 26 December 2004, a Mw9.3 earthquake occurred on the interface of the India and Burma plates just to the west of northern Sumatra. At a depth of 10 km (6 miles), approximately 1,000 km of fault ruptured to the north of the main shock, although almost all of the slip was concentrated in the first 400 km (250 miles). A devastating tsunami was propagated east and west of the main fault rupture into the coastal regions of Sumatra, Thailand, Myanmar, southern India, Sri Lanka, and the Maldives. Further west it caused damage in the Seychelles and eastern Africa. 230,000 people lost their lives and the economic impact has been estimated at around US$ 10 billion.

On Saturday 27 February 2010, at 03:34 local time, a powerful earthquake struck offshore of the Maule region in central Chile. Occurring along the interface between the Nazca and South American plates, this subduction zone event caused severe ground shaking across a 660 km (400 miles) swath of the country and generated a tsunami that ravaged the coastline. 800 people were killed and the economic loss stood at US$ 30 billion.

One year later, on Friday 11 March 2011, at 14:46 local time, a Mw9.1 earthquake occurred off the coast of northern Japan, rupturing an area approximately 450 km long and 150 km wide and triggering a massive tsunami that inundated over 525 km² of land along the coastline. This event generated economic losses of up to US$ 235 billion and killed nearly 16,000 people.

THE BLIND SPOTS FOR CATASTROPHE MODELS

The Tohoku Earthquake and Tsunami constituted an unprecedented event, whose devastating economic and social impacts on Japan – which include the worst nuclear crisis since Chernobyl – will have a lasting impact on the culture of risk management both within the country and throughout the world. This event highlighted a number of limitations with respect to current catastrophe models, such as the potential for non-modelled associated tsunami damage. Overall modelling should benefit in the coming year from a new scientific understanding of the seismic sources affecting Japan.

Although the tragic and devastating Indian Ocean tsunami event in December 2004 took the lives of 230,000 peoples, it was only a modest event in terms of its impact on the insurance industry due to the low insurance penetration in the region, it certainly has drawn attention to the wide variety of exposed business lines and the vulnerability of assets in coastal areas to sea flooding. Property, Life and Health insurance and Travel insurance have certainly been impacted: industrial plants, coastal tourist hotels, resorts, claims from foreign tourists, repatriation, and so on. Elsewhere in the world, a tsunami in the Caribbean would be very likely to impact all these lines of business once again. Moreover, although less at risk from very large (say, Mw8.5+), the Caribbean zone is seeing an increased concentration of exposure along the coast. Caribbean is almost entirely covered by models, but none are coupling tsunami and shaking. Cascadia Subduction Zone off the northwest coast of North America is also an area of concern due to the potential for very large earthquake and proximity to major metropolitan areas of Vancouver, BC and Seattle, WA.

The relatively low casualty count and degree of destruction from the Chile event, considering its high magnitude, demonstrates the success of the application of the Chilean seismic building code. However, the geographical concentration of highly interdependent industrial risks, illustrated how Business Interruption losses are compounded over time and this element of coverage was not well reflected in the modelled loss.

After Tohoku, catastrophe modelling firms have started implementing inundation areas into their software corresponding to historical tsunami events. This allows users to better control their exposure by performing accumulations, but does not allow them to allocate capital or to price programs and crucially is not *coupled* to shake risk assessment. As an industry, we simply cannot afford to ignore non-modelled perils, and it is important that insurers and reinsurers develop approaches designed to bridge any gaps in their risk management and capital modelling frameworks. New initiatives such as Oasis (see related article in this publication) will help to support the creation of alternative models for existing perils, and of new models for non-modelled perils and territories.

TSUNAMI RISK IN THE MEDITERRANEAN SEA

Until recently, it was a widely held belief that tsunamis either did not occur in the Mediterranean Sea, or were so rare that they did not pose a threat to coastal communities. Catastrophic tsunamis are more frequent on Pacific Ocean coasts, where both local and transoceanic tsunamis have been documented. However, large tsunamis actually occur in the Mediterranean Sea every few decades, although their memory is short-lived.

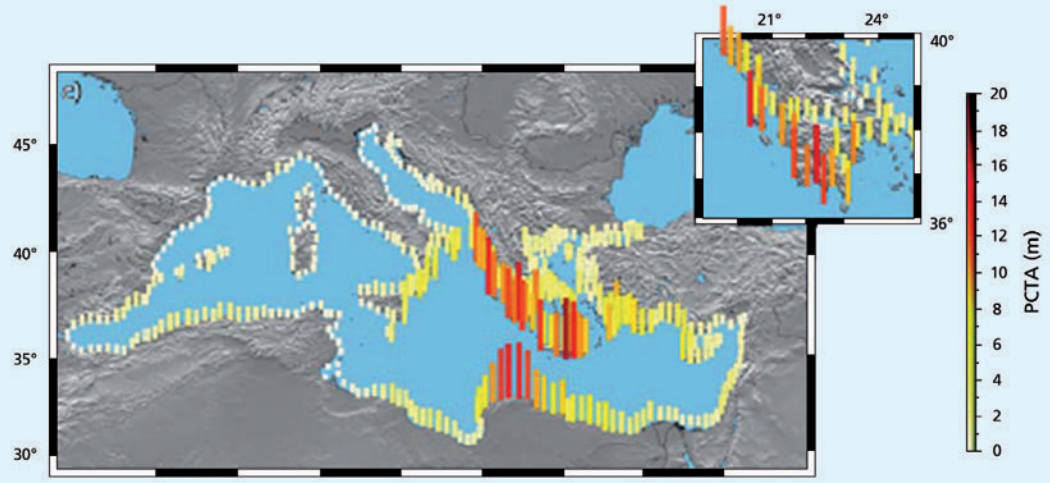
Because of the active lithospheric plate convergence in the region, the Mediterranean Sea is geo-dynamically characterized by high seismicity and significant volcanism. Furthermore, coastal and submarine landslides are quite frequent, partly in response to the steep terrain that characterizes much of the basin. Up until the beginning of the 20th century, tsunamis were sporadically mentioned in earthquake descriptions or catalogues. By the early and mid-20th century some research had been carried out, following large tsunami events such as the Messina event in southern Italy (28 December 1908) and the south Aegean Sea event in Greece (9 July 1956). More systematic efforts to compile tsunami catalogues for the Mediterranean began in the 60s, when some progress was made in the fields of numerical wave modelling and tsunami hazard assessment. The beginning of the 1990s marked a key turning point for tsunami science in the Mediterranean Sea region and in Europe in general. Recently, major progress has been made in the Mediterranean region across the full spectrum of tsunami science, technology and risk mitigation.

In a study published in 2005, Papadopoulos et al. concluded that, in the Mediterranean Sea, a very strong tsunami is expected every 140 years on average. From a geographical point of view, very strong events are associated either with highly seismogenic zones like the Messina straits (1783, 1908), southern Italy and the Gulf of Corinth (373 B.C., 1748), central Greece and the Hellenic arc (365, 1303), or with the active volcanic complex of Thera and the South Aegean Sea (1600 B.C., 1650 and 1956, with run-up heights reaching 25 m). In 2003, an underwater earthquake north of Algeria generated a tsunami with run-up heights up to 2 m in the Balearic Islands. The major tsunami of 1600 B.C. has been cited as contributing to the destruction of the Minoan civilization in Crete (Antonopoulos, 1992). There is a consensus among the scientific community that earthquakes are the cause of at least 75% of the tsunami events in the Mediterranean Sea.

Sorensen et al. (2012) have proposed the first probabilistic tsunami hazard assessment in the region and show that the tsunami hazard is concentrated in the eastern Mediterranean at relatively short timescales. The areas particularly affected are south-western Greece and Crete, the southern Aegean islands and Cyprus, north-western Egypt, north-eastern Libya, and south-eastern Italy, with tsunami heights of up to about 1 m expected on a 50-year return period. Over longer timescales, the authors show that the entire Mediterranean region is affected by the risk of tsunamis. And again the greatest risk lies in the eastern Mediterranean, where waves exceeding 5 metres can be expected in many places.

The probabilistic way of representing tsunami risk gives a better insight into the situation via the de-aggregation exercise, which identifies key risk areas: the Hellenic arc for the eastern Mediterranean, the north Algerian coast, and Sicily and Calabria in the western Mediterranean. The Strait of Sicily has been identified as an efficient barrier for travelling tsunamis, implying that there is no exchange of tsunami waves between the Eastern and the western Mediterranean. Sorensen et al. (2012) have also estimated the possibility of issuing a tsunami warning in various areas according to travel time. In general, the public has a 30 minute window in which to take cover if a tsunami is generated in one of the above-mentioned key areas. In Messina, Algeria and Marmara Sea, however, local earthquakes allow relatively little time in which to issue warnings.

Figure 4: **Probabilistic tsunami hazard in the Mediterranean sea**



Source: Sorensen et al. 2012

After the Indian ocean tsunami of 26 December 2004, the IOC (the Intergovernmental Oceanographic Commission of UNESCO), which was established in 1960, received a mandate to coordinate the efforts of the UNESCO Member States to implement Tsunami warning systems in the world's ocean basins, including the Mediterranean Sea. Progress relating to such research will certainly help to tailor the recently-tested Mediterranean warning system.

TSUNAMI RISK MANAGEMENT

There will be another tsunami… it's just a matter of time. Potential losses for the insurance industry are amplified by increasing insurance penetration in emerging markets, global interconnectedness and clash potential.

Prudent catastrophe risk management should involve the re-examination of exposure accumulations across the most catastrophic loss scenarios and the consideration of a range of scenarios for concentrations of risk, such as the Tokyo region or other megacities. Furthermore, more detailed data should be captured and utilized when assessing risk for high resolution perils, such as tsunamis or floods. Geospatial analysis skills and tools are important for developing customised views of tsunami risk and SCOR can help its clients to define a tailored approach to managing this risk. Other initiatives, such as Oasis and recent academic papers will help us to better reflect this risk in our risk management frameworks.

Finally, it is fundamentally important that any new models reflect the variety of ways that tsunami is covered (or not) under local policy wordings, because while it can't stop the damage, policy terms and conditions can be useful tools to reduce the uncertainty and mitigate losses to insurers.

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8

THE COPENHAGEN CLOUDBURST EVENT JULY 2-3 2011

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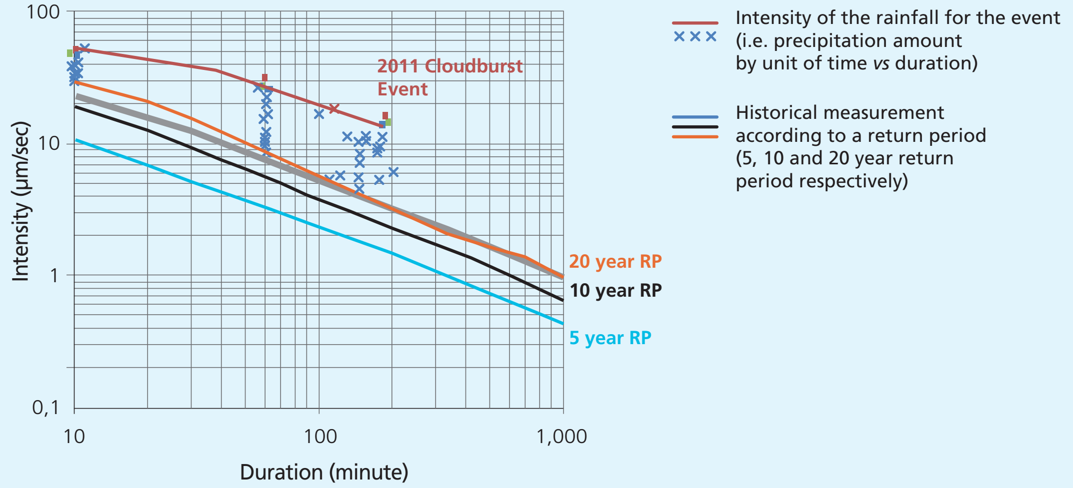
On July 2nd the Copenhagen Metropolitan area was hit by torrential rainfall. Within less than two hours more than 100 mm of rain was measured by the Danmarks Meteorologiske Institut (DMI) in the centre of Copenhagen. The highest intensity of rain was 30 mm in 10 minutes. In addition, 12,000 lightning flashes were recorded during the event with some resulting in losses.

The DMI defines cloudburst as more than 15 mm of precipitation within 30 minutes. According to the Danish Insurance Association (Forsikring og Pension) a “violent storm” means that the rainfall is so powerful that the drainage system cannot cope with the sewage water – respectively 40-50 mm of rain in 24 hours or 1 mm of rain per minute.

This July 2nd event was an extraordinary one, as evidenced by the comparison to previous rainfall events recorded by the DMI:

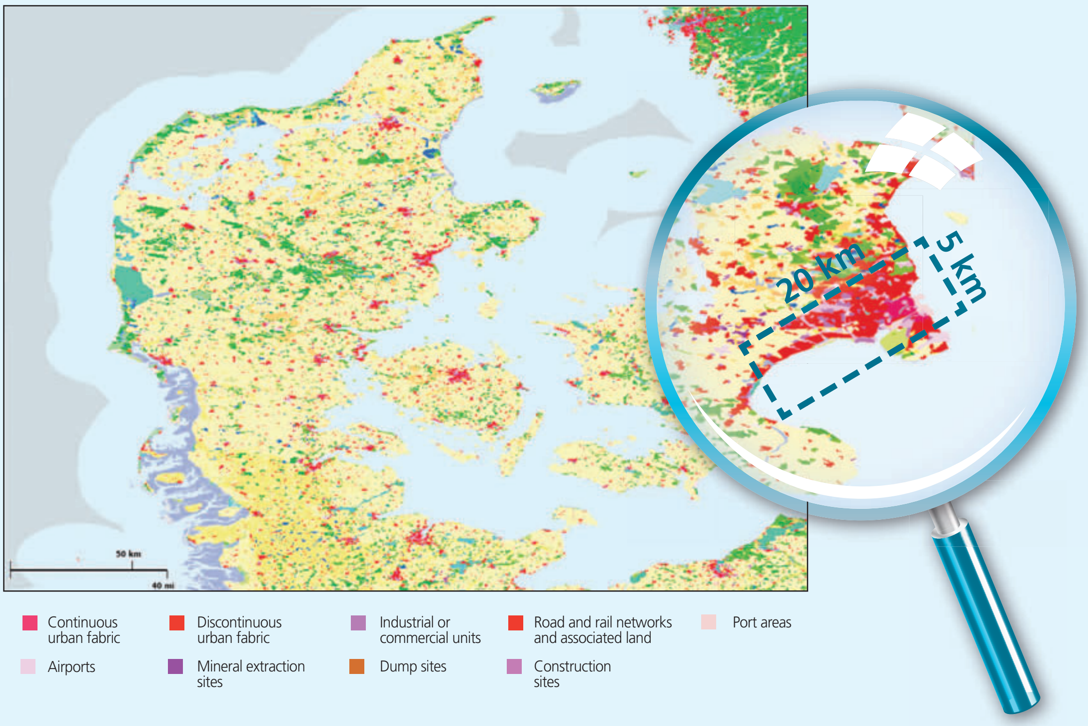
Figure 1: **The 2011 cloudburst event**



Flooded streets in Copenhagen after Cloudburst event – July 2011

The urbanized area of Copenhagen covers about 100 km² and has a high value concentration consisting of offices, shops and stores, apartment blocks, hospitals, schools, and commercial buildings. Many of these are located in basements, making the city vulnerable to flooding because of the limited space for absorption.

Figure 2: **Land cover in Denmark showing urbanized area (in red)**



Source: Corine Land Cover 2006 raster data - version 13 (02/2010)/ European Environment Agency (EEA)

As the drainage systems were not designed for such large amounts of water in a short period of time, the combined effects of drainage, terrain, soil and surface conditions contributed significantly to the risk of water damage. As a result many basements were flooded, the Copenhagen transport network collapsed, and important motorways and railway lines were flooded. Emergency services were also impacted, with hospitals being close to evacuation, and the failure of the Police headquarters telephone system.

The event from a claims management perspective

From a Danish perspective the cloudburst was an absolute extreme scenario: an exceptional number of losses occurred within a short period of time on a weekend during the holiday season. A challenging situation for all insurance companies.

As the event took place in a very "local area", many insurers were not equipped to service all of the claims right away: thousands of clients were calling to report losses right after the event and to ask for instructions, but some companies were not able to answer all incoming phone calls immediately. This caused a delay in registering the losses. Some insurers even asked their clients to report minor losses at a later point in time so they could focus on major losses first. Insurance companies with a strong emergency plan in place and with clear predefined internal logistics and responsibilities had a great advantage, and insurers with call centers benefitted from their infrastructure, enabling them to process many of the incoming phone calls right away.

The current number of reported losses is around 125,000, with an estimated DKK 6 billion loss (≈ € 807 million) outstanding compared to the previous year's cloudburst events, as shown in the graph below.

Figure 3: **Cloudburst losses in Denmark 2006-2011 in mDKK**

Source: Forsikring og Pension

In Denmark, home insurance policies as well as commercial/industrial policies cover losses emanating from cloudbursts (as defined by the DMI) and rising sewer water. Losses arising from sea surge and river flood are covered by the Danish Flood Fund, a self-sustaining, public fund.

For all flooded property, the first steps in minimizing the claims costs are rather simple, but are not always easy to implement and are very labour intensive:

- Pump the water out of the building – this took several days because of drainage systems not working and lack of material.
- Remove all wet/moist material such as drywall, wooden materials, carpets, etc. from the building.
- Clean and disinfect the rooms because of potentially contaminated sewage water.
- Start dehumidifying the basement/building.

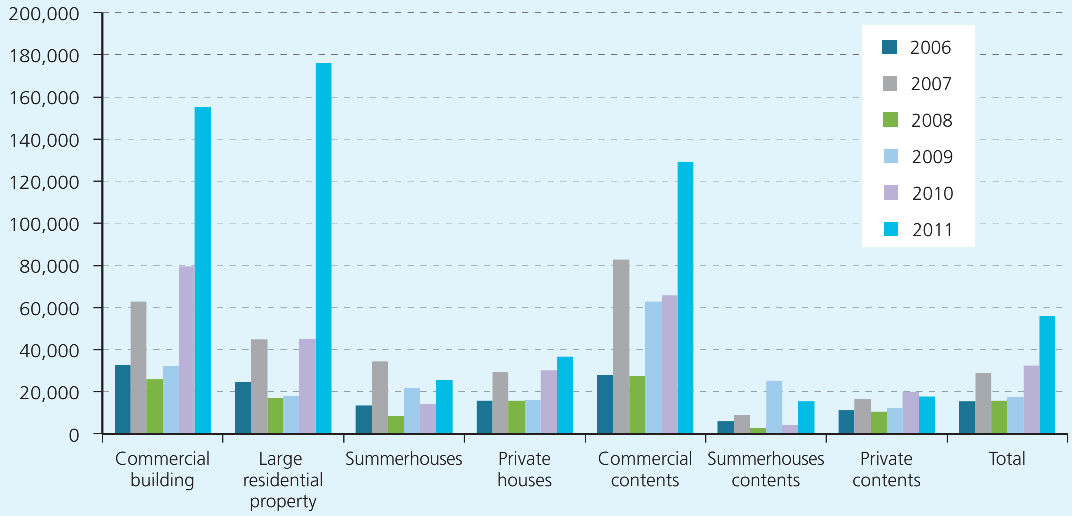
Many insurance companies had agreements with external service providers in order to adequately respond to the needs of their customers and help them to restore their property. An event of this magnitude shows the limits of such arrangements in terms of availability and respective exclusiveness: if various insurers use the same sub-contractors there could be a potential bottleneck in service.

Claims service companies were under high pressure: thousands of dehumidifiers were needed and many were imported from border countries. They had to quickly hire personnel to service their clients' needs. In many cases these workers only had limited know-how. It is estimated that the cloudburst event generated 3,000 man-years of extra work.

Establishing a sufficient claims reserve in the initial phase was a challenge for insurance companies. Many companies based their initial loss estimates on their experience with the 2010 cloudburst event. However, they soon learned that this loss estimation method was insufficient due to the high percentage of commercial property affected. This created significantly higher average losses compared to previous years, which can be seen in Figure 3. This graph shows the average loss amounts for Danish cloudburst losses from 2006 through 2011.

Because of the particular situation in Copenhagen with many basement shops and restaurants, numerous companies experienced flooding in basements and storerooms with a high value concentration. Commercial customers were more affected and their losses (contents and buildings) were more expensive than first anticipated. Apart from drying and replacing interiors, commercial clients also experienced losses of rent and income.

Figure 4: **Cloudburst losses 2006-2011 in Denmark – Average loss amounts 2006-2011 in DKK**



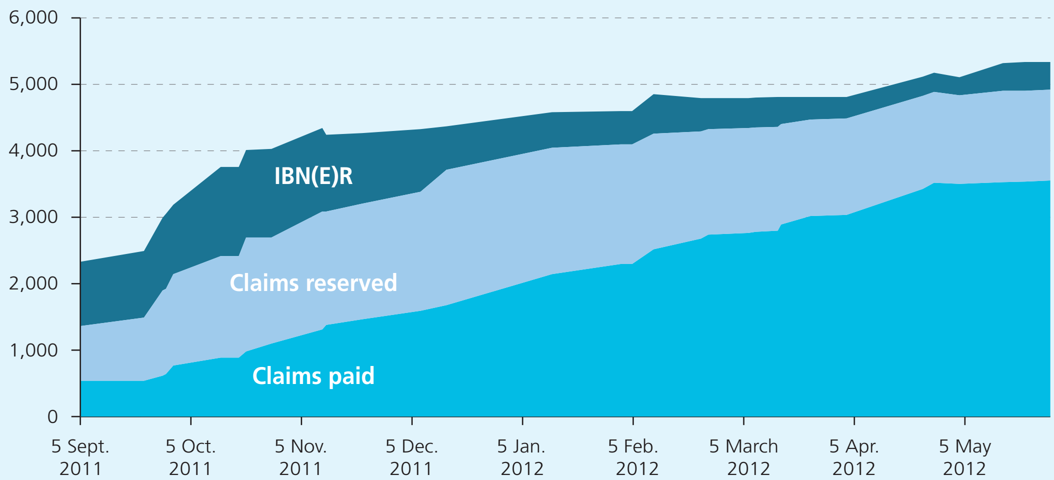
Source: Forsikring og Pension

Many commercial losses were supervised by loss adjusters internally and externally. Large losses needed to be visited several times. Minor losses up to a certain threshold were regulated via a simplified procedure, i.e. by using lists of destroyed contents and photographs. Insurers aimed to regulate minor losses quickly by paying lump sums, although the thresholds for these payments varied by company.

Another problem for many insurance companies was the prolonged repair periods due to mould. Massive amounts of moisture had been absorbed in the affected buildings/basements and because of a shortage in craftsmen, claims assessors and dehumidifiers, the problem was exacerbated. Mould is often discovered after a longer period and we have already seen an increase in the number of mould losses and consequently an increase in the loss reserves. In the future, the focus should be on the prevention of such losses through the use of non-organic material in exposed areas such as basements.

Figure 5 shows the loss development as reported to SCOR. The reported loss as at the end of May 2012 is more than double initial estimates, which underlines the extraordinary size of this event. Almost a year after this cloudburst event there are still many reserves. According to Forsikring og Pension, only 50%-60% of the losses were settled by the end of March 2012. This is partly due to a shortage in carpenters and claims assessors. It also shows that it takes longer to repair the damage because the properties need to be totally dry before they can be restored.

Figure 5: **Development of Copenhagen cloudburst as reported to SCOR in m DKK**



Source: SCOR

Financial impact of the loss

The 2011 Danish Cat reinsurance capacity is estimated at DKK 25-30 billion (≈ € 3.5-4 billion), with corresponding reinsurance premiums of around DKK 600-700 million (≈ € 80-90 million). Cedants' retention amounts to DKK 700-800 (≈ € 95-100 million). This implies a reinsurance cover ratio of 85-90% of the overall expected loss of DKK 6 billion (≈ € 807 million), respectively representing a gross loss to reinsurers of DKK 5.2-5.3 billion (≈ € 710 million). These figures do not take into account international entities covered under global reinsurance programs. Thus primary insurers were well protected by their reinsurance programs and only carried 10% to 15% of the loss.

Market reaction

Copenhagen experienced heavy rainfalls for the second year in a row after the August 2010 downpour and more frequent and severe cloudbursts are expected in the future, with severe financial implications – and not just for the insurance industry.

As a consequence of the recent event there have been many initiatives by various institutions such as the government, communities, and insurance companies. The main focus is to be better prepared for similar events in the future and to reduce potential damage.

Insurance companies have strengthened their underwriting guidance for flood prone areas in general. They continue to provide professional advice for customers on claims prevention, and have introduced risk management measures such as limiting coverage for organic materials in basements and underground premises, as well as introducing storage height requirements for contents at 20-40 cm above floor level. They also propose the use of additional anti-flood devices, such as back-flow protectors, based on individual assessments. Furthermore deductibles, in particular for basements, have been introduced, or increased where already in place.

Internally there are initiatives such as improving risk classification and accumulation control in areas that are unlikely to benefit from large-scale community flood defenses and in areas that are at high risk of flash flooding in the event of cloudburst (topographic location).

A new service from the insurance industry has been developed and recently launched in collaboration with the DMI and Engineering Consultants COWI: the Insurance Weather Service (Forsikringvejret.dk). A two day weather forecast is now available with the option to be alerted to severe weather by SMS. The service provides information accurate to one square kilometer regarding the severity and extent of the storm.

Figure 6: **Insurance Weather Service in Denmark**

The Copenhagen Climate Adaptation Plan, published in 2011 by the Copenhagen community, addresses problems related to more frequent and heavier rainfall expected in the future and shows how Copenhagen can cope with this. The plan discusses how to manage rainwater, especially as sewer capacity is limited and needs to meet future increases in rainfall.

On a broader scale, the Environmental Minister has established a National Dialogue Forum for Climate Change Adaptation. This Forum will identify the challenges of climate change for Denmark and discuss climate change adaptation solutions.

From a reinsurers' perspective there were no concerted increases in capacity observed, although a few insurance companies extended their programs. Retention levels did not change significantly. Thorough assessment of cedants' claims management procedures and their controls are an important part of SCOR's renewal process. After the cloudburst event, we are particularly focused on the emergency plans of insurers and their cooperation with claims service companies.

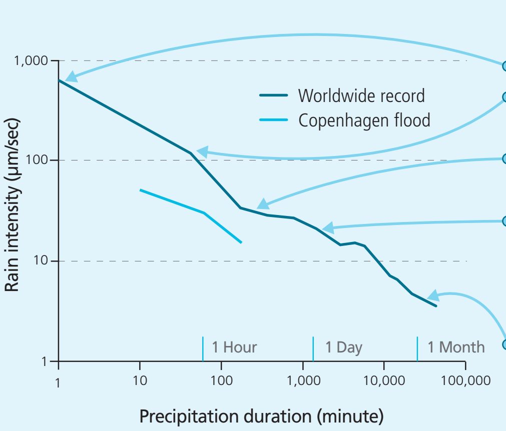
The January 2012 renewals saw an impact on pricing due to the cloudburst event, with a 25% to 35% premium increase for reinsurance programs affected by the heavy rain event. Due to adverse claims development there is a need for further pricing adjustments over the coming year.

SCOR's positive momentum, sustained by the recent rating upgrades, underlines our commitment to the market with strong capacity and security. We continue our strong franchise in Denmark with a focus on long-term relationships with our clients.

Outlook

From a historical perspective this cloudburst was a very extreme event for Denmark. It is the second largest loss in Danish history after storm Anatol in 1999. On a worldwide scale, extreme rainfall events have occurred with impressive frequency and a severity which by far did exceed the Copenhagen flash flood. However they took place in less populated regions than Copenhagen, e.g. in La Réunion island or in India. But overall population increases which are more pronounced in urbanized areas amplify potential risks and outcome to extreme rainfall events.

Figure 7: **Rainfall intensities and precipitation duration of exceptional events**



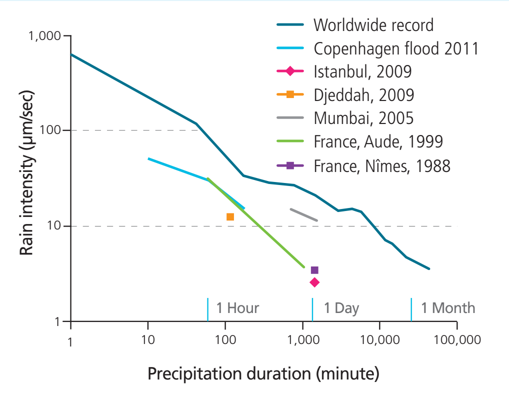
Duration	Location	Date	Rainfall amount (mm)
1 minute	Barst, Guadeloupe	26/11/1970	38
42 minutes	Holt, USA	22/06/1947	305
3 hours	Foc-Foc, La Réunion	08/01/1966	361
6 hours	Foc-Foc, La Réunion	08/01/1966	620
12 hours	Grand Ilet, La Réunion	26/01/1980	1,170
24 hours	Foc-Foc, La Réunion	07-08/01/1966	1,825
48 hours	Aurère, La Réunion	08-09/04/1958	2,467
4 days	Commerson, La Réunion	24-27/02/2007	4,869
15 days	Commerson, La Réunion	14-28/01/1980	6,083
1 month	Cherrapunji, India	July 1861	9,246

Source: compilation of Wikipedia and SCOR sources

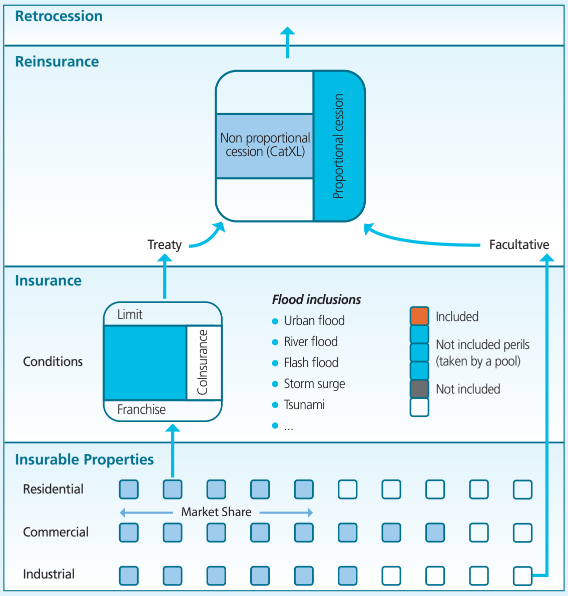
The Figure 8 tends to place in perspective all variables that take place during a flash flood event from its cause to its impact to a reinsurer from recent events.

Figure 8: Recent urban/flash flood in perspective

From a hazard/severity perspective.



From a risk transfer perspective.



Country	Denmark	Thailand	Turkey	Saudi Arabia	India	France	France
Event	Copenhagen	Bangkok	Istanbul	Djeddah	Mumbai	Aude	Nîmes
Year	2011	2011	2009	2009	2005	1999	1988
Flood type	Urban flood	River flood	Urban flood	Flash flood	Urban flood	Flash flood	Flash flood
Reinsurance Loss (in m€)							
Amount	710.0	5,000.0	270.0	136.0	250.0	-	-
Ratio RI/Ins	88.8%	50.0%	90.0%	90.7%	41.7%	0.0%	0.0%
Insured Loss (in m€)							
Amount	800.0	10,000.0	300.0	150.0	600.0	400.0	315.0
Ratio Ins/Eco	80%	22%	33%	20%	10%	80%	63%
Economical Loss (in m€)							
Amount	1,000.0	45,000.0	900.0	744.0	6,000.0	500.0	500.0
In % of GDP	0.30%	12.9%	5.40%	0.14%	0.15%	0.02%	0.02%

Resulting in different loss impact.

Sources: SCOR

Flood management is of growing importance to the markets because it is a mean to reduce flood impacts, but understanding its reduction is key for risk assessments (e.g. in certain cases it can be worsen, i.e. Thailand flood). From a risk assessment perspective, flood is one of the most complex hazards to model. Four modules need to be taken into account:
- Meteorological (rain);
- Hydrological (transformation of rain into discharge);
- Hydraulic (discharge propagation into a river system) and;
- Local propagation (flood defence, terrain feature).

The modelling is very data intensive (data volume and resolution) and complex (flood algorithm), which could be a reason why so few vendor flood models are being available.

Increased insurance penetration, along with increased urban density and increased hazard all lead to the question of pricing sustainability when dealing with such perils.

9

CATASTROPHE CAPITAL UNDER SOLVENCY II

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When they happen, major natural catastrophes can be devastating and insurance companies can be confronted with thousands of claims to manage simultaneously. Even if mitigated by reinsurance the potential often exists for catastrophes to wipe out earnings and consume capital, which makes catastrophe risk an important component in the calculation of Solvency Capital Requirements (SCR). As the European insurance industry prepares for Solvency II, the framework for the quantitative assessment of the SCR Catastrophe component has evolved as lessons are learned from successive Quantitative Impact Studies (QIS) undertaken by regulators across Europe.
In this paper we look at the alternative methods available for calculating catastrophe capital under the latest QIS, as well as the implications for using external Cat models as part of an internal model under the Solvency II directive.

Figure 1: **Recent history of Cat risk methods available under Solvency II**

		QIS4 2008	QIS5 2010	Solvency II? 2014?
Standard formula	Std	**1.** Factor Method **2.** National Scenarios	**1.** Standardized Scenarios **2.** Factor Method	**1.** Combined Standardized Scenario/Factor Method
	USP (1)	**3.** Personalised Scenarios (allowing Cat models) →	No option	No option
(Partial) Internal Model			Cat models	Cat models

(1) Undertaking Specific Parameters.

QIS4 Cat Methods

Under the QIS4 Standard Formula, three options were available to regulated insurance and reinsurance companies, all of which were problematic in some way for either insurers or regulators. The premium-based Factor Method (see Figure 2) fails to differentiate between insurers doing business in higher catastrophe risk areas such as earthquake prone countries in the eastern Mediterranean (or even the French Dom Toms) and in more benign region from a catastrophe risk perspective such as Spain. While premium may be a useful proxy to describe relative risk for insurers selling homogeneous products (such as homeowners insurance) and operating within a single country, it is clearly a poor proxy measure for catastrophe risk across countries in Europe.

Figure 2: **Premium Factor Method**

Events	Lines of Business	Gross factor
Storm	Fire, Motor, other	175%
Flood	Fire, Motor, other	113%
Earthquake	Fire, Motor, other	120%
Hail	Motor, other	30%
NPL Property	NPL Property	250%
NPL MAT	NPL MAT	250%

Under Method 2: National scenarios, each local regulator was required to design deterministic scenarios that represent characteristic 1:200 Cat losses for each country. While this tried to address a key limitation of the Factor Method, the wide variety of methodologies that emerged was a function of the data and expertise available to each regulator. Ultimately this meant that National scenarios were very inconsistent and presented questionable risk relativities across markets in Europe. Some observers also suggested an element of political influence in the calibration of the scenarios, with some regulators being more conservative than others depending on the level of capitalisation of their respective domestic markets.

Helping to address the weaknesses of Methods 1 and 2 under the Standard Formula was the option to use an Undertaking Specific Parameter (USP) in the form of a Personalised Scenario. This meant that insurers with significant Cat risk could design scenarios that reflected the complex mix of business lines and geographic distribution, often drawing on the use of catastrophe loss modelling already embedded in the risk management activities of the company. While this was a good solution for insurers and reinsurers, regulators felt that it was difficult for them to validate such USPs under a Standard Formula, and determined that Cat models would only be allowed as part of an approved internal model with all of the attendant technical rigour and transparency through documentation required under the internal model approval process.

After the post-QIS4 consultation process it was clear to EIOPA [1] that the significant issues with the Standard Formula methods for Cat needed to be addressed, and a Catastrophe Task Force was formed in September 2009, chaired by the FSA (the UK regulator), to develop a new harmonised approach for Catastrophe Risk (Natural and man-made [2]) in QIS5 that was consistent, proportionate and fair across Europe.

QIS5 Cat Methods

The key output of the Catastrophe Task Force was a new set of standardised scenarios for each country in EEA, developed using a consistent approach [3]. Central to the design of the new scenarios was the decision that, in order to be *risk sensitive*, the scenarios should be driven by the exposure (rather than premium) profile of each insurer. Furthermore, in order to reflect risk gradients where the particular hazard varies within a country, as well as the potential for geographic concentration (or indeed diversification), exposure inputs to the calculations needed to be more granular than "Country"-level. Having determined that, the next question is inevitably: how granular? The locational sensitivity to risk from river flooding is much higher than for, say, extra-tropical winterstorms like Lothar or Daria. Depending on the elevation of the property, a distance of just a few meters can mean the difference between suffering a flood loss or not.

While higher resolution allows for better differentiation of risk, in this question the Cat Task Force took a pragmatic approach and balanced granularity against the need for simplicity and availability of data, both in terms of exposure inputs to the formula and data with which to calibrate the methodology. In the end, CRESTA [4] zones or the equivalent administrative sub-region were chosen as an appropriate and achievable geographic segmentation level.

(1) *EIOPA is the association of insurance regulatory bodies in the EU, known as CEIOPS in 2009.*
(2) *Man-made catastrophe includes: fire conflagration (e.g. Buncefield/Toulouse), marine (Piper Alpha), aviation disaster, terrorism, liability (Asbestos).*
(3) *Link to document on EIOPA website: https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/submissionstotheec/CEIOPS-DOC-79-10-CAT-TF-Report.pdf*
(4) *CRESTA stands for Catastrophe Risk Evaluating and Standardizing Target Accumulations (full details www.Cresta.org).*

Footprints *vs* Hazard Maps

While calibration to 1:200 or 99.5% VaR is fixed under the Solvency II directive, a key decision faced by the CTF related to the design methodology of the scenarios. One approach would be to prescribe a series of 1:200 event footprints for each country/peril combination, against which each insurers exposure would be used to calculate a gross loss. This is the basis used by Lloyd's in the Realistic Disaster Scenario [5] (RDS) framework, and has the useful feature for regulators that the calculated losses for each company can be simply summed to determine the total loss to a given event across a cohort of regulated entities. A significant drawback arises, however, if a selected scenario footprint happens to "miss" the exposure of a regional insurer that only operates in a part of the country not affected by the chosen event. Figure 3 below illustrates this problem using the Netherlands as a case study.

Figure 3: **Footprint issues illustrated for the Netherlands**

Figure 3a) shows a 1:200 windstorm event footprint for the Netherlands, with high damage levels (red:green <=> high:low) in the coastal south. For a well-diversified, nationwide insurer the event would be a reasonable selection as the exposures are distributed similarly to the wider market. Figure 3b) and 3c) show exposure profiles for two different regional insurance companies (pink:blue <=> high:low), which would lead to very different catastrophe capital requirements. In Figure 3b) the event selected represents a direct hit, while not representing a good fit as 1:200 for 3c).

To overcome this problem, a "hazard map" type approach was chosen where damage levels are calibrated to 1:200 for every CRESTA zone. This ensures that even very small or idiosyncratic exposure profiles are "hit" at 1:200 calibration, but creates a new problem in that it is unrealistic that every zone in a county has a 1:200 natural catastrophe at the same time. In order to address this problem a large correlation matrix for each country is used in conjunction with CRESTA risk relativity factors, resulting in a standard approach which reflects the specificities of each insurers geographic mix while remaining calibrated to the 99.5% or 1:200 level of loss.

One feature of the standardised scenarios is that if the aggregated total sums insured are plugged in to the formula, regulators can see the potential market loss for a 1:200 scenario. Indeed, the ratio of 1:200 loss for a given country to the total Sums Insured for that country is known as the Country "Q" factor. Figure 4 shows the latest "Q" factors under draft Level 2 Solvency II guidance.

(5) RDS specifications can be found on Lloyd's website at www.lloyds.com/rds

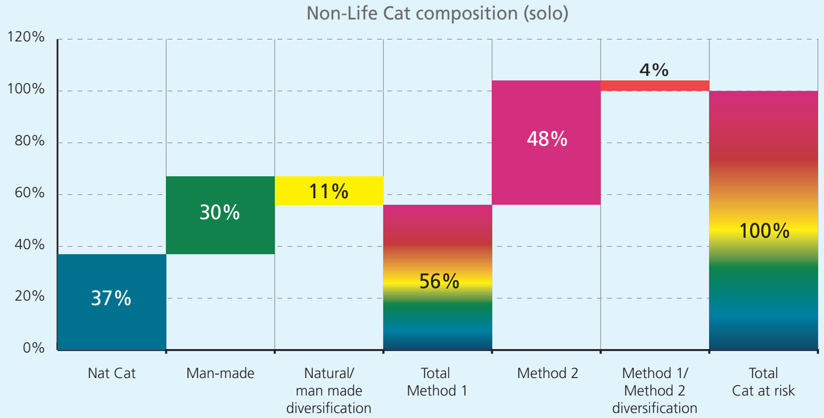
Figure 4: **QIS5 Standardised Scenario country "Q" factors**

Country	Windstorm	Earthquake	Flood	Hail	Subsidence
Austria	0.08%	0.10%	0.15%	0.08%	
Belgium	0.16%	0.02%	0.10%	0.03%	
Bulgaria		1.60%	0.15%		
Croatia		1.60%			
Cyprus		2.12%			
Czech Republic	0.03%	0.10%	0.40%		
Switzerland	0.08%	0.25%	0.15%	0.06%	
Denmark	0.25%				
France	0.12%	0.06%	0.10%	0.01%	0.05%
Germany	0.09%	0.10%	0.20%	0.02%	
Greece		1.85%			
Hungary		0.20%	0.40%		
Iceland	0.03%				
Ireland	0.20%				
Italy		0.80%	0.10%	0.05%	
Luxembourg	0.10%			0.03%	
The Netherlands	0.18%			0.02%	
Norway	0.08%				
Poland	0.04%		0.30%		
Portugal		1.20%			
Romania		1.70%	0.40%		
Slovakia		0.15%	0.45%		
Slovenia		1.00%	0.30%		
Spain	0.03%				
Sweden	0.09%				
UK	0.17%		0.10%		
Guadeloupe	2.74%	4.09%			
Martinique	3.19%	4.71%			
St Martin	5.16%	5.00%			
Reunion	2.50%				

While the Cat Task Force has delivered a more harmonised, risk sensitive and equitable approach to natural hazard scenario design, there remain many cases that are not well catered for under the standard formula particularly non-proportional risks and the handling of risk mitigation techniques, especially reinsurance, which is a fundamental tool used by the industry to protect capital. While it is understandable that EIOPA and the European Commission expect larger, more complex entities to embrace an Internal Model approach, the limitations which persist under the Standard Formula for Nat Cat makes it a poor benchmark against which internal model results to assess.

Figure 5, drawn from the QIS5 Playback [(6)] published by EIOPA, shows that across Europe the standardised scenarios (Method 1) were used marginally in preference to the Premium Factor Method (Method 2). Assuming that Nat Cat represents a similar proportion to total Cat under both Method 2 and Method 1 would suggest that Nat Cat risk accounts for around 55% of the total Cat risk (non-life companies), translating to approximately 22% of total gross Non-Life underwriting risk.

Figure 5: **Contribution to QIS5 Cat by method, further segmented Nat Cat/man-made for Method 1**



(6) *Link to EIOPA report: https://eiopa.europa.eu/fileadmin/tx_dam/files/publications/reports/QIS5_Report_Final.pdf*

Using Cat Models as part of an Internal Model

As mentioned above, if an insurer or reinsurer has a complex (including Non-Proportional, Non-EEA, Industrial, etc.) catastrophe risk profile that is best represented by a detailed catastrophe modelling approach, the only way the Solvency II framework can accommodate this is as a component part of a full internal model. While a small handful of companies have the internal resources to develop their own Cat models, for the vast majority of the insurance industry using Cat models means licensing one or more of the three main commercial vendors [(7)].

This creates some nervousness on the part of regulators and raises some important questions like: is the vendor model appropriate for the risk profile of the insurer? Could the myriad of model options be used to minimise capital needs? Is the model properly understood by management? To assuage such concerns, the Directive makes specific reference to the use of external models (and data) when calculating capital requirements under Article 126 (see Figure 6).

Figure 6: **Article 126 – Use of external models and data**

Article 126

"The use of a model or data obtained from a third party shall not be considered to be a justification for exemption (emphasis added) from any of the requirements for the internal model set out in Articles 120 to 125"

- Article 120 Use Test
- Article 121 Statistical Quality Standards
- Article 122 Calibration Standards
- Article 123 Profit and Loss Attribution
- Article 124 Validation Standards
- Article 125 Documentation Standards

This clearly (and rightly) put the responsibility back on insurers to demonstrate that any use of 3rd party vendor Cat models is done in a robust way, demonstrating expertise and technical understanding of the complex mathematical models. Particular emphasis has been placed on the validation of external models, although gaining full access to the data and detailed underlying methodologies used can be challenging since, in essence, the embedded IP *is* the commercial product.

Article 126 is extremely open ended and the industry has tried hard over the last two years to establish more precisely what regulators' expectations will be with respect to external models. For example, does vendor model *version* change such as we saw in 2011, constitute an internal model change? With the high concentration of complex, global reinsurance and specialty lines writers in the London market, UK insurers have been most proactive in trying to establish expectations and the Association of British Insurers (ABI) has published a useful guidance note entitled: "Industry Good Practice for Catastrophe Modelling" [(8)].

While questions remain, it is important to recognise that Solvency II *raises the bar* in terms of demonstrating robust catastrophe risk management, although fundamental to this success is the recognition from all stakeholders that the overarching *principle of proportionality* must be applied.

(7) Applied Insurance Research (AIR), EQECAT and Risk Management Solutions (RMS).
(8) ABI publication can be downloaded from their website: http://www.abi.org.uk/Publications/59999.pdf

10

DIVERSIFICATION AND CATASTROPHIC COMPLEXITY

VICTOR PEIGNET
Chief Executive Officer
SCOR Global P&C SE

This article addresses the challenges facing reinsurers in terms of achieving optimal diversification in their portfolios in an increasingly complex world, with a special focus on natural catastrophes.

Key features of the Reinsurance business model

The reinsurance industry is no different from any other industry, being affected by the same waves of change in terms of business models as other industries and having its own cycles to manage.

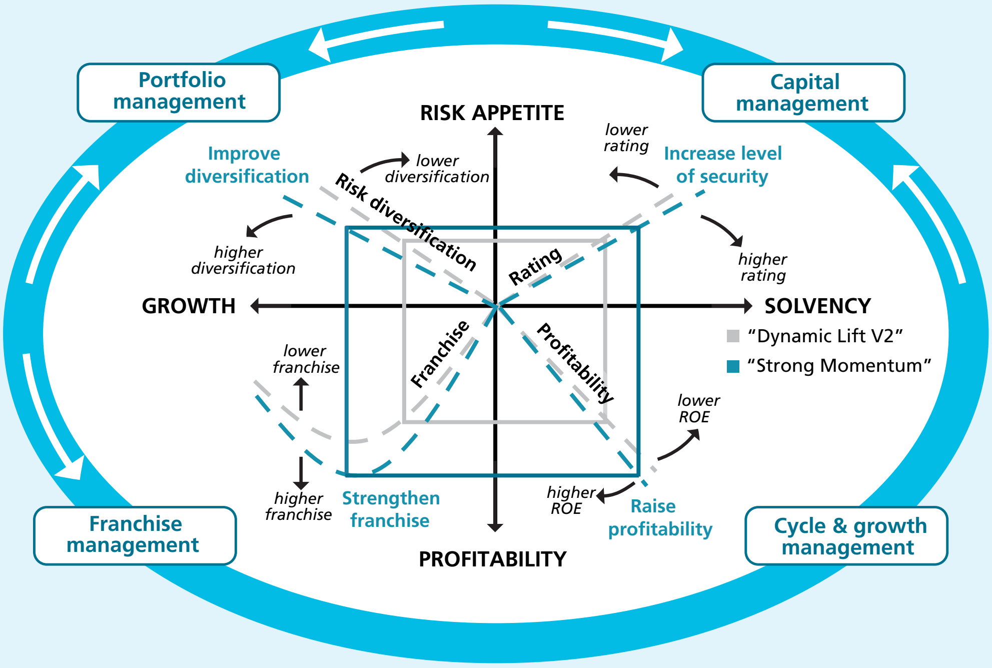
Ours is a capital-intensive industry and financial flexibility is one of the key factors on which reinsurance companies are rated. Over the years, we have seen a shift from being state-owned or private equity-backed companies towards a predominantly public industry, listed in the most influential financial centres. As a consequence of this transformation, reinsurance players are exposed to the pressure and turbulence of the financial markets, without special treatment from financial analysts or investors despite their track record, and the resilience they have demonstrated in times of extreme crisis relative to other companies that fall under the umbrella term of *Financial Services*.

Along with the troubled banking sector, the reinsurance industry is also becoming increasingly regulated. This explains why it has been advocating against assimilation with the *Banking* industry and is seeking recognition of its positively differentiating factors, in the on-going debate over systemic risk (although with limited success for the present).

In addition to the mounting regulatory pressures, the reinsurance industry is also subjected to a rating process that is probably more discriminating than in most other industries. Facing competing constraints and demands from many stakeholders, the equation of the reinsurance business is certainly one of the most complicated for any economic activity.

This equation can be characterized by the three letters **G**, **P** and **S**, which for the reinsurance industry does not stand for Global Positioning System, rather **Growth**, **Profitability** and **Solvency** (see Figure 1) – the three key performance indicators by which each reinsurer is benchmarked.

Figure 1: **Optimising targets in a coherent and consistent framework**



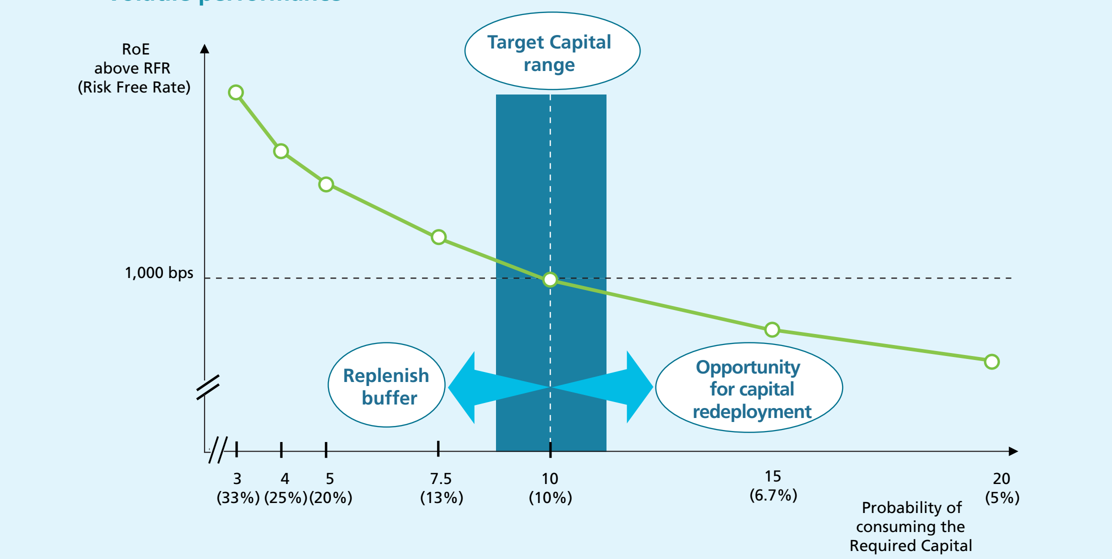
Risks, particularly *peak*, *emerging* and *latent* ones, are the raw materials of the reinsurance industry, while *risk aversion* is one of the dominant features of developed societies. Consequently the offer and value proposition of reinsurers, which consists of transferring, transforming and managing society's most volatile risks, is likely to face increasing demand. However, the prolonged crisis of 2008 and the slow and uncertain pace of economic recovery are challenges facing the **G** and the **P** parameters of this equation, adding to the burden of the series of exceptionally heavy natural catastrophe losses recorded over the last two years.

Being a capital-driven industry, the optimal deployment of capital is the challenge behind the **S** parameter of this equation. For reinsurers to adapt to changing economic and political environments and to anticipate and manage business trends, capital *fungibility* and *transferability/mobility* are essential. Meanwhile, we face a counter-trend of strengthening local regulation and solvency requirements which is tending to force dispersion of capital on reinsurers, locking it in to specific markets.

In such a context, the success of reinsurers will depend on their ability to satisfy the following two competing demands:

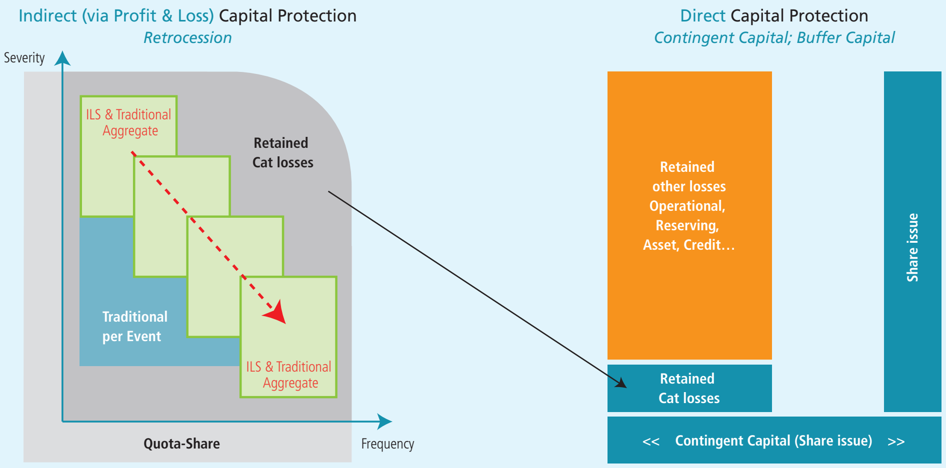
- Demonstrating to investors that their business provides a *solid* and *stable* TOTAL return on their capital (RoE in Figure 2), through clear communication and reporting on *risk appetite* and managing expectations on *risk/reward*.
- Proving to regulators that the capital requirements are being managed and satisfied, at both group and solo-entity levels.

Figure 2: **The Risk/Return trade-off; higher returns are always possible but only through more volatile performance**



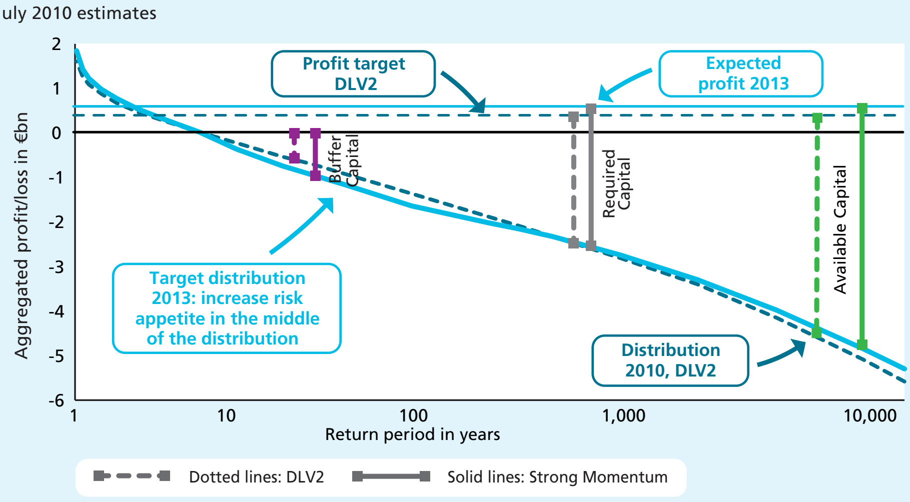
In the case of SCOR at its current "A+" range rating, this alignment has led to the addition of a buffer capital on top of the required capital, and the implementation of a tailor-made capital shield policy (see Figure 3), so that the Group's shareholders are not exposed as *de facto* retrocessionnaires.

Figure 3: **SCORs tailor-made Capital Shield; a diversified set of risk transfer tools can help fine-tune the retained risk profile, while reducing dependency on any one counterparty or mechanism**



It also led to a moderately increased risk appetite in the centre of the distribution when the Group successfully completed its "Dynamic Lift V2" 3-year plan and entered into its "Strong Momentum" plan (see Figure 4 below).

Figure 4: **Optimizing the Risk Profile**

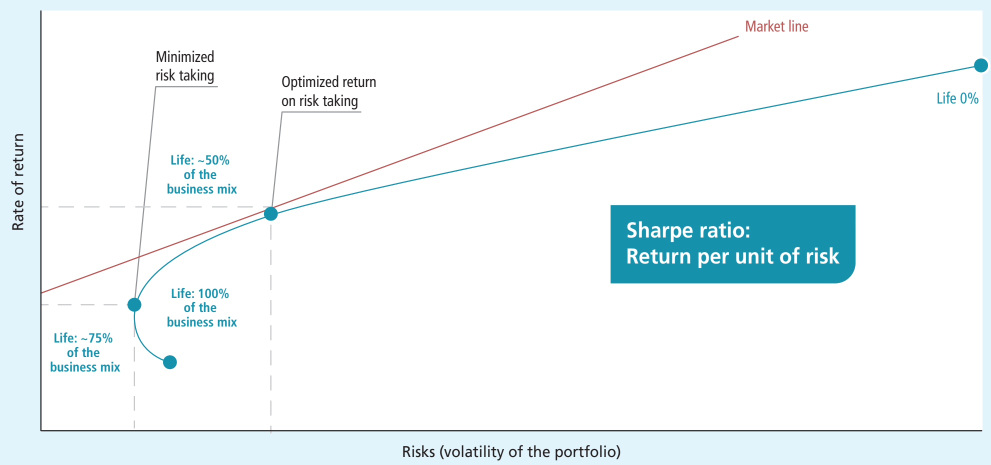


Internal model framework

Addressing stakeholders needs against an increasingly *global* risk landscape with complex risk interconnections explains the massive investments that reinsurers are making in terms of developing internal models. This also explains evolutions in the purpose of internal models, from "value protection" to "value creation" [(1)].

The current form of modelling not only aims to identify and quantify risk, but also to manage the portfolio, and to develop insight into the centre of the distribution as well as in the tail. Taking public information as a reference, the results of the internal modelling for the SCOR Group, based on its balance sheet as at 31 December 2009 and its plan for 2010, can be summarized as follows in Figure 5:

Figure 5: **Risk/Return curve based on the Life/Non-Life Business Mix. We see from the results of the internal model an *efficient frontier* representing the optimal mix of Life and Non-Life Business, balancing higher returns with lower volatility**



The technical results of the internal model show substantial *diversification* benefits due to the combination of portfolio management and optimization at both global and individual segment levels and we explore a number of distinct methods for achieving diversification, in the context of a Natural Catastrophe portfolio.

(1) Via "value sustainment" thanks to a quantitative approach to Risk Management and Value-at-Risk and Tail Value-at-Risk as risk measurement tools.

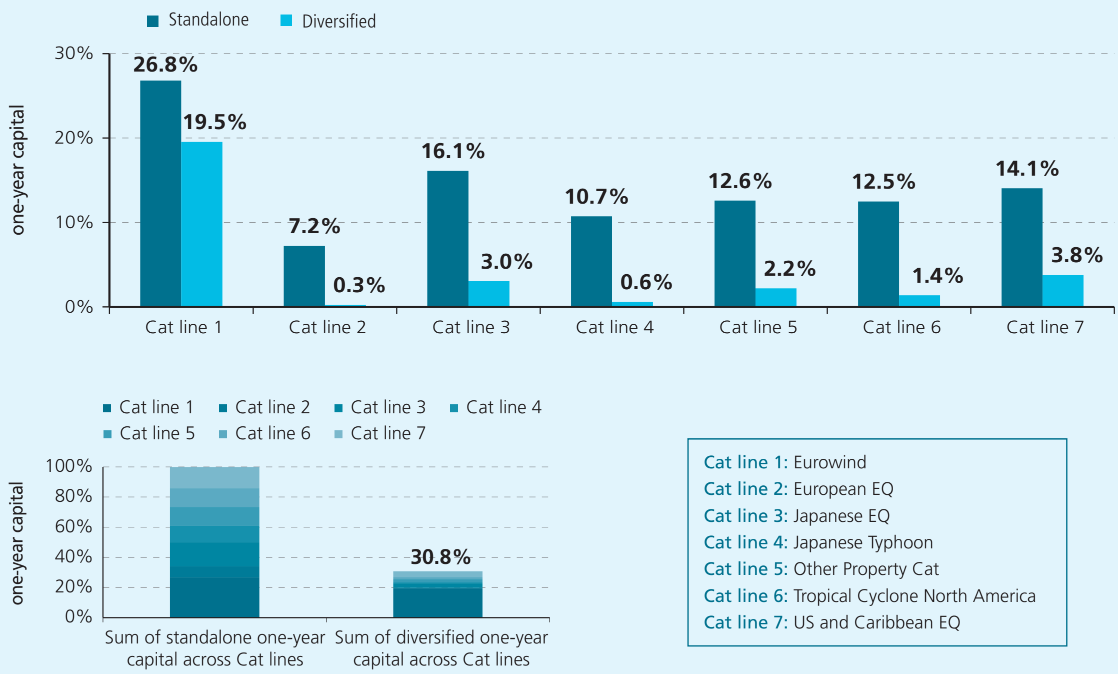
Diversification methods

DIVERSIFICATION WITH OTHER CAT LINES

While it is traditionally assumed that writing non-Cat lines is the ideal way (see below) to diversify a Cat portfolio, underwriting a portfolio of relatively independent perils is already a material step towards achieving diversification benefits.

We see (Figure 6 below) that writing a globally diversified Cat portfolio involving many Cat lines (Peril x Region) can reduce the sum of the standalone capital for the various Cat lines by 69.2%. Clearly, this sub-additivity is an attractive feature and encourages reinsurers to actively seek out "non-peak zone" Cat risks. With the level and frequency of Cat losses in Q1 2011, some are learning the hard way that the benefits from this income are not free, and that additional risk has a downside.

Figure 6: **Diversification from writing different Cat lines**



100% represents the sum of (Gross) standalone one-year capital across all Cat lines

Indicative, for illustration purposes only

Lessons learned and further considerations in terms of building a balanced and sustainably diversified Cat portfolio include:

1. *Timing risk* – eroding Cat budget and/or capital ahead of seasonal peaks (3rd quarter = US Hurricane) may necessitate expensive defensive strategies (2).

2. *Recouping losses* – peak zone losses are often catalysts for market hardening, allowing quicker recoupment of losses/repair of capital erosion than may be the case for non-peak territories.

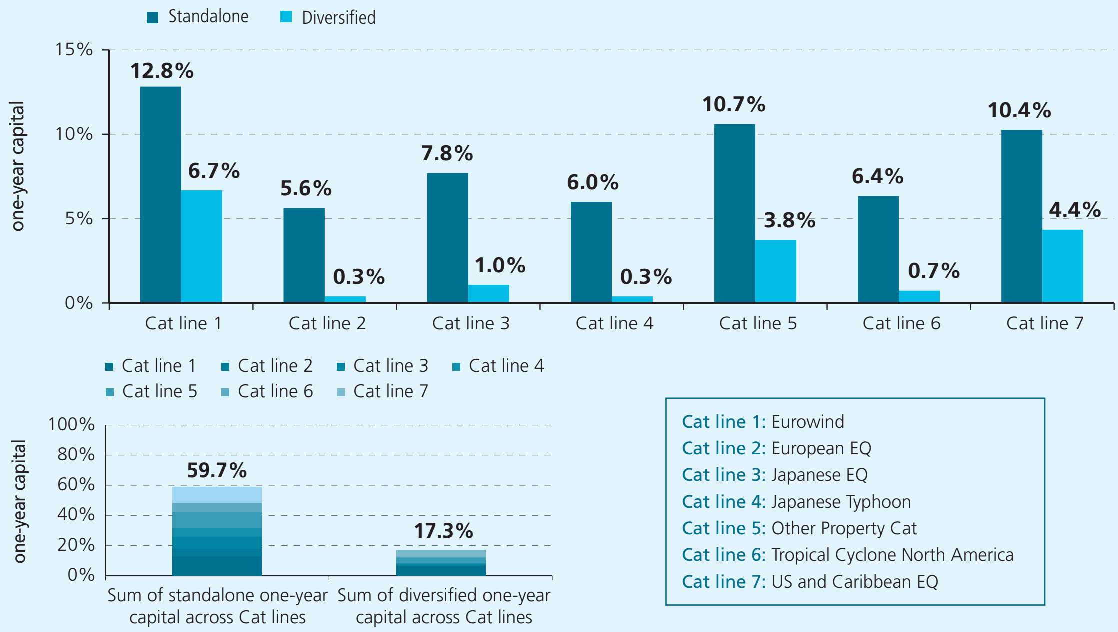
3. *Economic context*
   a. Economies subject to austerity measures and flat/low growth may limit the ability of cedants to meet the challenges of a post-loss response to insurance and reinsurance pricing (3).
   b. Similarly, the larger the Cat loss potential as a proportion of GDP, the longer it will take to recoup losses.

(2) This could include reducing exposure (which hits top line) or distressed purchase of additional risk transfer instruments (affecting bottom line).
(3) When people have no spare disposable income they sometimes choose un-insurance ahead of accepting premium increases.

RE-BALANCING CAT LINES USING RETROCESSION

As well as the direct capital benefit of transferring risk (at economically competitive costs to Retrocessionaires, Cat Bond holders etc.) by reducing the economic loss in the most extreme cases, further diversification benefit is achieved through re-balancing Cat lines to similar volume and volatility. Figure 7 below shows a 40.3% reduction from Gross to Net Standalone capital; while the diversified Net capital reduces 43.8% from 30.8% (refer to Figure 6) down to 17.3%.

Figure 7: **Diversification benefit: writing different Cat lines (Net figures)**

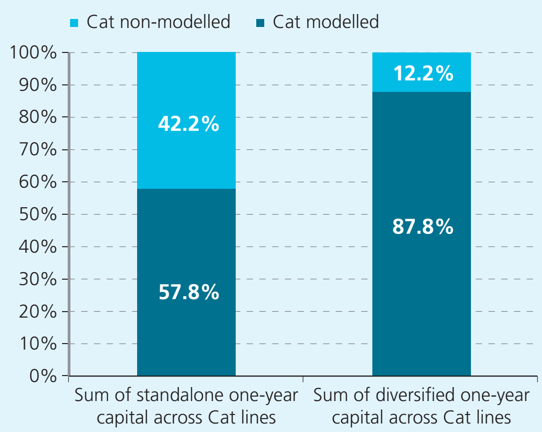


Indicative, for illustration purposes only

For global insurers and reinsurers, the contribution of *non-modelled*[4] Cat lines to total Cat risk is significant, even though the contribution to the Net portfolio 1:200 decreases with respect to the Gross, since non-modelled perils are often smaller in size than modelled ones. Over the 5 years 2006-2010, SCOR's net losses attributable to non-modelled events was approximately a third of all Nat Cat losses, with flood losses predominating. Even after diversification, the non-modelled lines represent 12.2% of the overall net Cat total.

Figure 8: **Impact on "modelled" & "non-modelled" Cat lines**

Diversification writing different Lines of Business and different Business Maturities (New Business and Reserves) (Net figures)



Cat tools while mature, are not yet comprehensive.
Don't forget the "non-modelled"!

(4) *In this context we refer to Peril x Region combinations that are not supported by commercial suppliers of Cat models; all Peril x Regions are represented in the Internal Model.*

DIVERSIFICATION WITH OTHER NON-CAT LINES

Diversification benefit applies across Cat and non-Cat lines; however only the Cat lines are displayed on Figure 9 below, that shows a further 42.2% reduction of the diversified Net capital from 17.3% (refer to Figure 7) down to 10%.

Figure 9 (a): **Diversification benefit (Net figures). Further benefit when diversified with other lines of business and with reserves**

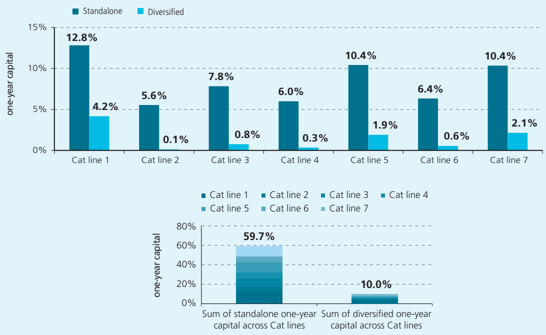
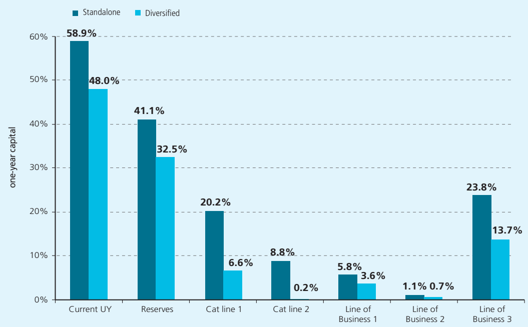


Figure 9 (b): **Diversification benefit: (Net figures) – Illustration of the whole portfolio**



Cat line 1: Eurowind	Cat line 5: Other Property Cat
Cat line 2: European EQ	Cat line 6: Tropical Cyclone North America
Cat line 3: Japanese EQ	
Cat line 4: Japanese Typhoon	Cat line 7: US and Caribbean EQ

As expected material diversification benefits can be realized by additionally writing non Cat lines. Scale is still based on GROSS for comparison to the two previous slides, showing the combined effect of Retro and diversification with other lines.

100% = sum of GROSS standalone one-year capital across all Cat lines
Note, diversification is across Cat and non-Cat lines, however, only the Cat lines are displayed

Similarly, a global Cat portfolio aids in the diversification of the non-Cat lines. Scale is now the NET Standalone Capital of the whole portfolio, including reserves

100% = Standalone NET one-year capital Current UY + standalone NET one-year capital Reserves

Indicative, for illustration purposes only

As we have already seen, significant reductions in the capital needed to write Cat lines can be achieved through a combination of diversification effects and risk transfer – however this is not a sustainable business model for all but a handful of reinsurers. Witness the demise of the mono-line Cat Reinsurer as specialist Cat players seek to write other non-Cat lines to maximise diversification. Take care though – it takes a significant amount of additional resources (=expense) to extend from Cat only to multi-line reinsurer, and it is critically important to capture the dependencies with the Property Cat lines:

1. Direct impact from Cat on Marine, Engineering or Motor own damage.
2. The economic impact a Cat may have on Property non-Cat costs as labour and materials inflate.
3. The indirect impact a Cat may have even on Credit & Surety, as companies that have exhibited poor risk management (un-insured or under-insured) become more likely to go bankrupt.

Nonetheless, while it is important to capture this dependency, the overall dependency is relatively low, generally enabling diversified Non-Life companies to generate material diversification benefits.

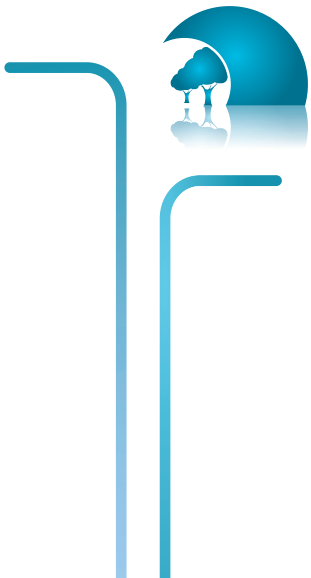
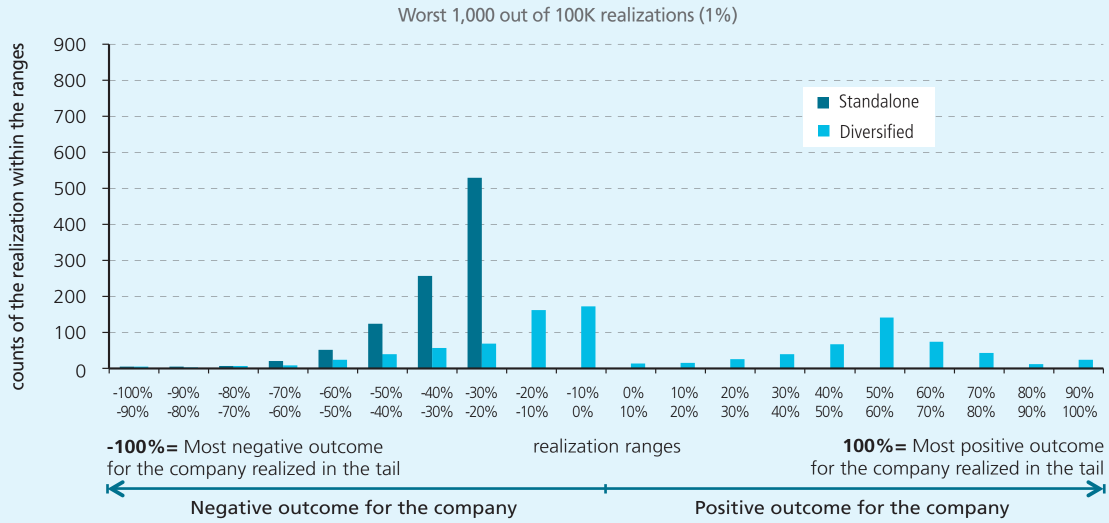


Figure 10 below shows the cumulative effect of diversification from all three methods. We can see that the *diversified* (net) contributions for Cat line 1 exposures are not limited to very bad outcomes, but still quite frequently relate to relatively good outcomes that occur when the company's bad overall results are driven either by other Cat lines or other non-Cat lines.

Figure 10: **The effect of Retro on standalone and diversified Cat capital**



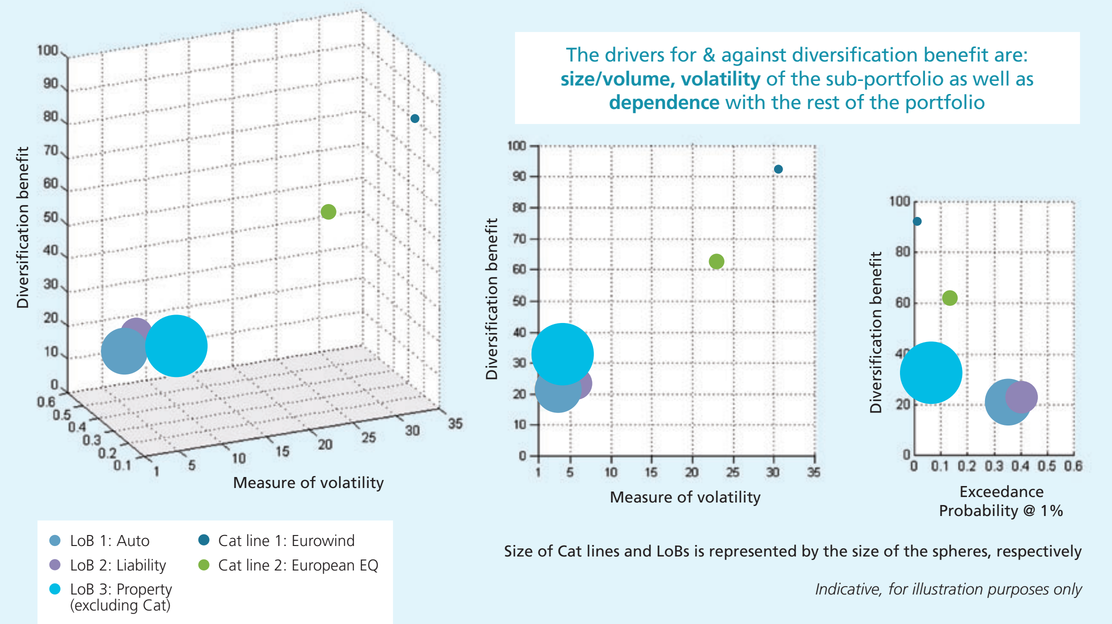
100% represents the sum of (Gross) standalone one-year capital across all Cat lines (cf. Figure 6)

The three variables that affect the capital contributions of a portfolio are the *size* and *volatility* of the portfolio and its *dependency* with other risks, and understanding the interplay of these influences can help to determine the choice of alternative scenarios to be considered in strategic decision-making and planning, for example:

- Determining the optimal mix of Cat business within a Cat portfolio (Mechanism 1).
- Determining the optimal retrocession structure that limits the volatility and size of Cat lines so that the net cost of capital savings is maximised (Mechanism 2).
- Determining the optimal mix of Cat and non-Cat business within the entire book, (Mechanism 3).

Figure 11 displays for a sample of the line of business the three variables that influence diversification (size, volatility and dependence) and how diversification is inversely related to each of these three variables.

Figure 11: **Diversification benefit: different drivers for different Lines of Business (Net figures)**



Some cautionary concluding thoughts

Our climate *is* changing and while we cannot say that climate change "caused" a particular event, it does seem as though:

"The rising risk of extreme events has much in common with <u>playing with loaded dice</u>." (5)

One of the next key challenges for catastrophe risk modellers is to confront assumptions of *independence* between peril x regions that are explicit in the vendor Cat modelling tools, and as a result, often flow into internal capital models. Climate regimes such as ENSO, AMO and NAO (6) can simultaneously condition the likelihood of extreme meteorological and hydrological events occurring in multiple regions in the same financial year.

There has been a trend of increasingly frequent medium-severe to severe insured losses caused in particular by "localized" natural catastrophes such as tornadoes, wildfires, floods, hail storms, snow storms or frost, **all non-modelled or badly modelled**.

Aside from the shocks caused by major events, this trend is generating a recurrent and increasing burden from natural catastrophe insured losses in the technical results, which cannot be denied or ignored. In recent years, the record books show:

- **2010** tied with 2005 for the **warmest year globally**, as well as the **wettest since 1900**. We witnessed a heat wave and wildfires in Russia, flooding in Pakistan and Colombia, "Snow-zmaggedon" in Washington DC, and rounded it all off with the onset of the "biblical" flooding in Queensland in December.
- **2011** natural catastrophes caused the **biggest Economic Loss**, and will probably exceed 2005 in terms of **Insured Loss** once the consequences of Tohoku, New Zealand, and Thailand have fully developed.

A reinsurers' view of the ways and means to address the situation must be global, but may differ from one country or market to another. It will include applying the principle of mutualisation and seeking additional margins to cope with the observed deterioration of overall profitability.

(5) Huber, Daniel G. and Gulledge, Jay (2011) "Extreme Weather and Climate Change: Understanding the Link, Managing the Risk": Pew Center on Global Climate Change.
(6) ENSO: El Niño Southern Oscillation
AMO: Atlantic Multi-decadal Oscillation
NAO: North Atlantic Oscillation
UCAR: University Corporation for Atmospheric Research, based in Boulder Colorado.

If mutualisation proves to be unachievable in practice due to divergent market forces, reinsurers may consider each country or market as a pool and adjust the size of the assumed risk to the size of that pool – in other words, being sensitive to the "*small country or small market syndrome*".

Taking a longer-term view, it is clear that global demographic trends will play a role in determining growth opportunities for reinsurers in the coming decades. There is already research [7] which anticipates the future shifting patterns of global peak zone Cat risk. Florida, for example, experienced population growth of over 500% since 1950 and, while we do not expect the population of China or India to increase quite so dramatically, urbanisation and industrial development trends are creating the potential for new peak zone concentrations of catastrophe risk (e.g. Shanghai).

In a number of developing countries population trends combined with: a higher level of insurable assets due to economic growth (Physical Damage), higher corporate revenue streams (Business Interruption) and wealth creation, are increasing the need for risk transfer and driving insurance penetration.

As alternative territories compete in the future for "peak zone" classification, risk loads will have to adjust to changing diversification dynamics in order to reflect the changing amount of capital needed. This dynamic feedback in pricing catastrophe risk may act as a constraint to growth in some places, but could bring some welcome relief for the next generation of Floridians.

(7) Paper presented at the 2009 Aon Benfield Hazards Conference by Rade Musulin, Rebecca Lin and Sunil Frank.

SPEAKERS' BIOGRAPHIES

SCOR SPEAKERS

DENIS KESSLER

Chairman & Chief Executive Officer, SCOR SE

Denis Kessler is a French citizen, he is a graduate of HEC business school (*École des Hautes Études Commerciales*) and holds a PhD in economics as well as advanced degrees in economics and social sciences. He has been Chairman of the *Fédération Française des Sociétés d'Assurance* (FFSA), CEO and Executive Committee member of the AXA Group and Executive Vice-President of the MEDEF (*Mouvement des Entreprises de France*). He joined SCOR as Group Chairman and Chief Executive Officer on 4 November 2002.

VICTOR PEIGNET

Chief Executive Officer, SCOR Global P&C SE

Victor Peignet, Marine & Offshore Engineer graduated from the *École Nationale Supérieure des Techniques Avancées* (ENSTA), joined SCOR's Facultative Department in 1984 from the offshore contracting industry. He has more than 15 years underwriting and managing experience in Energy & Marine insurance with SCOR. He was at the head of the Corporate Business Division of the Group (Business Solutions) since its formation in 2000, as Executive Vice President and as Managing Director from April 2004.
Since July 2005, he has been the Chief Executive Officer of SCOR Global P&C that is one of the two operational entities of the Group and that manages the Group Non-Life business worldwide. He is member of the Group COMEX.

PAUL NUNN

Head of Catastrophe Risk Modelling, SCOR Global P&C SE

Paul Nunn is responsible for pricing catastrophe risk on inwards business, and accumulation of catastrophe loss potential for natural hazard perils globally. A key aspect of the role is the provision of analytics and data for internal and external stakeholders including SCOR internal capital model, rating agencies, regulators and retrocessionaires. Paul is also responsible for directing strategic Cat Platform system development. Before joining SCOR Global P&C, Paul was Head of Exposure Management at Corporation of Lloyd's responsible for all aspects of accumulation and concentration risk. Paul has held many senior level positions in catastrophe management having also worked for ACE European Group and Applied Insurance Research Ltd. Alongside his role at SCOR Global P&C, Paul is a director of the not-for-profit Oasis Loss Modelling Framework company.

HENRY BOVY

Regional Catastrophe Manager, SCOR Global P&C SE

Henry Bovy is Regional Manager of the Catastrophe Risk Modelling at SCOR Global P&C responsible for management of natural hazard perils from the Paris Hub. His responsibilities encompass managing the Cat portfolio (pricing and accumulation) for most of the EMEA Treaty book and the Fac portfolio (accumulation), support for data provisions for internal and external retrocession and capital model and model investigation. Henry has worked in the catastrophic area since 2000 with EQECAT (developing model like Eurowind or Euroflood), AXA Re/Paris Re (Cat modelling for branch offices in Montréal, Miami and Singapore) and AonBenfield prior joining SCOR P&C. Henry holds a master in Physics.

PETER KOEFOD

Chief Underwriting Officer, Nordic markets, SCOR Global P&C SE

Danish citizen, Peter Koefod started his career in direct insurance as a trainee. After five years, he joined what later became Employers Re in 1984 and spent 15 years in Copenhagen, Munich and Chicago working in Property Casualty treaty.

In 1997 he became Assistant General Manager in Copenhagen Re as Head of Treaty. He then joined Converium in 2002 as Chief Underwriting Officer for German speaking, Eastern European and Nordic markets. In 2008, he was appointed Chief Underwriting Officer at SCOR Global P&C as Head of Nordic markets.

KIRSTEN MITCHELL-WALLACE

Head of Catastrophe Pricing & Methodology, SCOR Global P&C SE

Kirsten Mitchell-Wallace is Head of Cat Pricing and Methodology for SCOR, based in Zurich and leading the catastrophe modelling for business written from Zurich. She has a deep understanding of catastrophe models and their application having worked in modelling a company (RMS), a broker (Willis) and a risk management consultancy.

She holds a PhD in atmospheric physics from Imperial College, London.

JAKIR PATEL

Senior Catastrophe Risk Portfolio Manager, SCOR Global P&C SE

Jakir Patel is Senior Cat risk portfolio Manager at SCOR Global P&C responsible for the team interface with Retrocession, Solvency II and rating agency departments within SCOR. Further responsibilities include taking a leading role in the on-going development of SCOR Global P&C catastrophe modelling framework and the preparation and analysis of the global catastrophe risk portfolio. Before joining SCOR Global P&C, Jakir spent almost 11 years as Head of Loss Modelling at Faraday Underwriting Ltd where he was responsible for all facets of loss modelling including the provision of Cat modelling technology, system development, pricing, portfolio management and reporting functions including those related to Lloyd's and the FSA. Prior to Faraday, Jakir spent around 5 years as a Research Engineer with Applied Insurance Research Ltd (AIR) where he worked on various models including European wind & quake and UK Flood.

Jakir holds a master in Structural Design and a degree in Civil Engineering.

GUILLAUME POUSSE

Senior Catastrophe Analyst, SCOR Global P&C SE

Guillaume Pousse has recently joined the Catastrophe Risk Modelling Department at SCOR Global P&C in Paris. His current responsibilities encompass the pricing activity of accounts exposed in earthquake prone locations and the investigations of model behaviour. Prior to joining SCOR, Guillaume has spent 4 years at AonBenfield in London, sharing its time between supporting brokers and developing earthquake loss models. Guillaume held junior level positions at Paris Re and at the French Institute for Nuclear Safety, where he obtained his PhD from in earthquake engineering.

GUEST SPEAKER

PETER TAYLOR

Technical Director, Oasis

Peter Taylor has 25 years experience as a director responsible for IT and analysis in the London insurance market. During his career in the market, Peter served on many committees, including the Working Party that developed the 2002 Lloyd's Realistic Disaster Scenarios. Peter authored the chapter on "Catastrophes and Insurance" published in "Global Catastrophic Risks" by OUP in 2008 and his essay "The Mismeasure of Risk" was published in "The Handbook of Risk Theory" by Springer in 2011.

Peter is a Research Fellow at the University of Oxford's James Martin 21st Century School and a Technical Director of the not-for-profit Oasis Loss Modelling Framework company.

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