New Insights into the NBCR Terrorism Modeling: CCR Approach for the French Insurance Market

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CCR expertise: from Natural Disasters to Terrorism modeling

Since many years, CCR has been developing Cat models to assess the French exposure related to the main Natural Disasters such as flood, sea-surge, terrain subsidence, earthquake or hurricane.

These models encompass a fully-integrated approach from hazard to loss estimation. They allow CCR to address the main questions related to its core-business:
- What would be the loss due to an incoming event? (estimation within a few days only)
- What would be the loss due to past events occurring nowadays?
- What is the mean average annual loss?
- Solvency II regulation

Thanks to its accumulated experience over the years on the Natural Disasters modeling, CCR has been starting to model Terrorism from late 2011.
What do we cover? What do we need to model?

● There are three Terrorism coverages in France:
  ❖ Properties for which coverage is mandatory since 1986
  ❖ Transportation (sea, ground, air) in relation to war risk
  ❖ Casualties with a specific compensation fund (FGTI)

➔ France is one of the most widely covered country for Terrorism acts

● The mandatory property coverage (Art. 126-2) includes the compensation of the followings:
  ❖ Damages directly related to conventional explosion
  ❖ Property remediation for any NBCR attacks including those occurring outside the French territory but with damages inside borders (since 2006)
  ❖ Business Interruption if the property suffered from a physical damage (NBCR deposits or blast effect)

➔ This coverage excludes containment and remediation of rubbles.

➔ This coverage excludes Contingent Business Interruption
What do we cover? What do we need to model?

• The current market is covered with different sub-coverage depending on the Total Sum Insured:
  - The large policies (TSI > 20 M€) are first covered by the GAREAT terrorism reinsurance pool on a market aggregation basis. CCR provides a further unlimited coverage in XS of 2.3 billion € annual loss. The attachment point now evolves on a yearly basis to reflect the market evolution.
  - The other policies (TSI < 20 M€) can be covered on the open market. However, as for larger policies, CCR offers an unlimited coverage. A major evolution will be introduced by CCR from 2013 as this coverage will now be in XS of minimum 20 M€ annual loss. CCR allows companies to group their exposure in order to compensate for the newly introduced 20 M€ minimal attachment point.

• To date, market agrees on the main and underestimated threat: the radiological attack (few grams of Cesium for example) with an improvised explosive device (carried in a backpack for instance).
Modeling

Hazard

Exposure

Loss

Damages

Model Timeline and Overview

● During 2011, CCR has been choosing a private partner (Aria Technologies) and validating the global framework of its model.

● Aria Technologies is a French company providing atmospheric, pollution and NBCR modeling both for public and military purposes (US-DoD, Brazil, Japan, France, …).

● In 2012, a specific tool has been developed for CCR and is now providing results on a deterministic approach.

● Further improvements will be made throughout the coming years especially to maintain the model in the state-of-the-art. For instance, CCR is currently supporting a study on radiological consequences of Fukushima Daiichi catastrophe.

● The model combines both the potential of a realistic hazard modeling using Computational Fluid Dynamics and CCR unique database on French insured policies (~ 28 millions of policies with location and insurance coverage) with up to 80% (still improving) of high-resolution geocoded data in dense urban areas where terrorism is most likely to happen.
Model Timeline and Overview

To date, CCR model includes the following features:

- High-res 3D mapping of buildings (~70,000 km² / ~100 % French urban areas)
- CCR target database: ~ 47,000 potential targets including Embassies, Touristic places, Worship places, Governmental buildings, Petrochemical facilities, Nuclear facilities (power plants & industrial), …
- French Weather stations network historical database
- First estimation of blast effects using TNO™ approach

**Full variability on all the parameters:** hundreds of deterministic events, taking into account all the parameters variability, are weighted to produce a maximum likelihood damages evaluation for a main scenario.

The variable parameters are:

- Location of the NBCR source: user-defined or using CCR target database
- Wind speed and wind direction: user-defined or constrained by the weather stations database
- Explosive quantity (in eq. TNT) of the explosive device
- NBCR product & quantity released: $^{137}$Cs, $^{60}$Co, $^{131}$I, $^{210}$Po, $^{192}$Ir, Sarin, VX, Phosgene, Anthrax, Sulfur hexafluoride, …
A State-of-the-Art model: creating and dispersing the NBCR plume

Stage 1
In the seconds following the explosion, the plume evolves by the sole energy provided by the explosion. Both the initial geometry and the mass distribution within the plume are computed in accordance to relevant studies (Sandia/Lawrence Livermore National Laboratories – USA).

Stage 2
As the plume is thermodynamically at equilibrium, after exhaustion of the energy provided by the explosion, the local wind (speed & direction) drives the dispersal pattern and control the fallout of the NBCR particles.

NBCR 3D dispersal pattern in Paris CBD (La Défense) with a westward wind.
A State-of-the-Art model: taking into account Fluid Dynamics and high-resolution 3D buildings mapping

Buildings effect
Far from the buildings, flow suffers no disturbance.
Closer to the buildings, flow is disturbed by low-pressure rotor effect at the rear of the building and vortex disturbances at the edges of the building.

 Fallon can be important even for places not facing directly the wind and the NBCR plume.
Scenario example: Radiological Attack on “Champs Elysées avenue” – Hazard modeling

Improvised Explosive Device:
→ 1kg TNT (or equivalent)
→ 100 TBq of $^{137}$Cs (~30 to 50 grams of pure product)
→ Can be carried in a backpack
→ Moderate event

Wind dispersal
Depending mostly on the wind direction, the fallout will be totally different and so will be the economic consequences.

What would be the real wind parameters if this attack occurs? There is no a priori wind preferred conditions for a scenario.

All the possible combination of weather conditions should be considered and modeled.

French legal exposure: 4000 Bq/m²
Scenario ~ Fukushima Daiichi (13 600 TBq $^{137}$Cs released in 8 days)
Scenario example: Radiological Attack on “Champs Elysées avenue” – Loss quantification

Global Loss estimation

Considering both the extent and the high concentration of the fallout, the global loss would necessarily be higher than the remediation cost and the business interruption.

⇒ The loss can be as high as the Total Sum Insured if all the buildings are demolished and then rebuild.

Loss for this single event: 24 to 60 bn€
From a single deterministic event modeling to a “semi-probabilistic” scenario

- When considering the scenario “Champs Elysées Radiological Attack”: damages related to each combination of wind direction and speed are modeled and weighted according to their frequencies over the historical weather database. The variability of other parameters (quantity of explosive, NBCR product and quantity released, location of source, …) is also modeled.

Scenario Loss estimation combining and weighting all the modeled events:

- **52 to 89 bn€**
- 51.7 bn€ → direct modeling
- 88.6 bn € → total sum insured
Towards a full-probabilistic modeling tool?

- Contrary to Natural Hazards, Terrorism can not be modeled using the same probabilistic approach. Many key questions should be addressed:
  - What kind of mathematics can we apply? (Poisson distribution vs. Game theory)
  - How to combine the usefulness of a terrorist attack, its feasibility (logistical burden, skills required, cost of equipment, …) and its chance of being successful?
  - How to define the annual probability of occurrence?
  - How would evolve this probability if a terrorist act occurs: lower probability on “main targets” and higher on “secondary targets”?
  - What is the effect of counter-terrorism on occurrence probabilities?

- CCR considers that the answers to those key questions are impeded by too many uncertainties and thus prefers a semi-probabilistic approach on reference scenarios.

- The reference scenarios are used to perform actuarial management of CCR terrorism coverage.

- The reference scenarios provide benchmark for clients, market and the French state.
Thank you for your attention