Nat Cat Modeling at CCR

Visit of polish delegation - 10 and 11 july 2012

List of perils covered by the compensation scheme for natural distasters

- In the non-exhaustive list of perils within the scope of the Act of 1982 (Floods, Earthquakes, Ground displacements (including drought), Seasurge, Avalanches, Cyclonic winds in French overseas territories),
  - Floods (55% over the 1990-2010 period)
  - and Drought (40% over the 1990-2010 period)

  are the most expensive hazards since the beginning of the Nat Cat scheme.

- Since 1982 no major earthquake occurred in the French mainland area, but there is a real exposure to this peril.

- Some French overseas territories are also exposed to earthquake (Caribbean) and to Cyclonic Winds (Caribbean, Reunion Island).

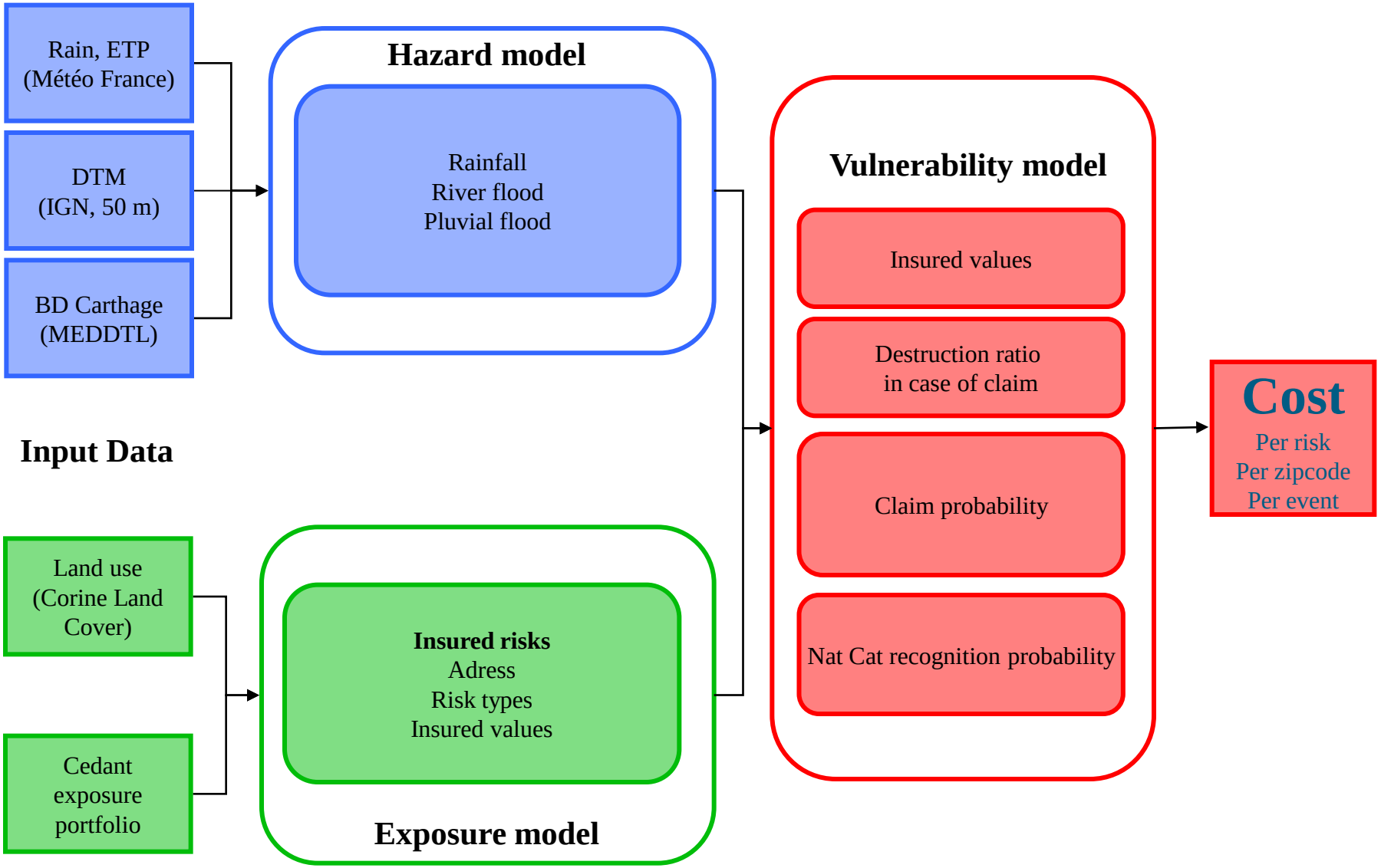
Nat Cat modeling at CCR

- For about ten years, CCR has developed natural distaster models to analyse the exposition of French territory.

- To achieve this work, CCR :
  - collects data on hazards, vulnerability and damages
  - develops their own models for the main perils : floods and drought
  - Uses and adapts editor models for other perils with potentially extremes losses : earthquake and cyclonic winds.

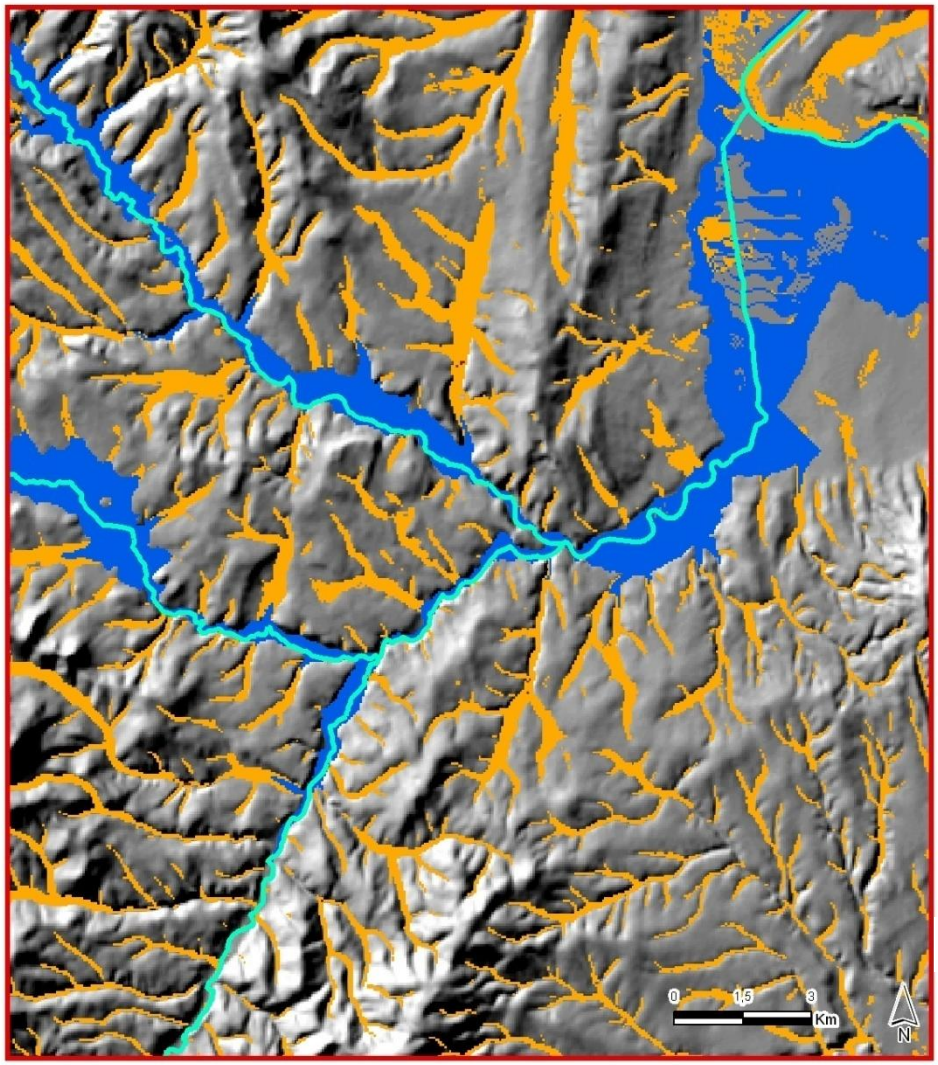
- These tools allow CCR to :
  - Estimate the cost of a major event a few days (or few weeks for drought) after its occurrence : this approach is called « deterministic »
  - Mesure the exposition for the insurance market, for CCR and for the French state : this approach is called « probabilistic »

General description of the flood model



Example of flood deterministic model

Floods : Center-East of France (november 2008)



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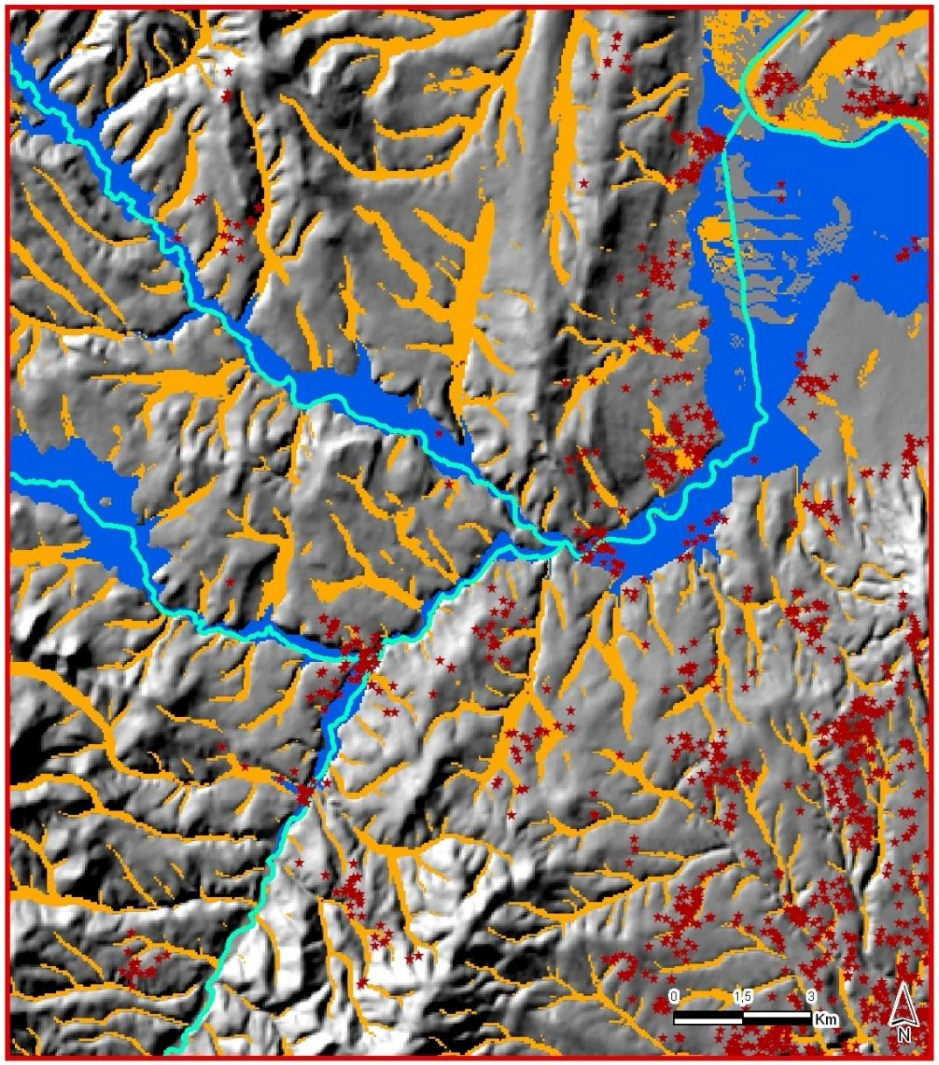

Risk database is not exhaustive and must be extrapolated to the insurance market

Example of flood deterministic model

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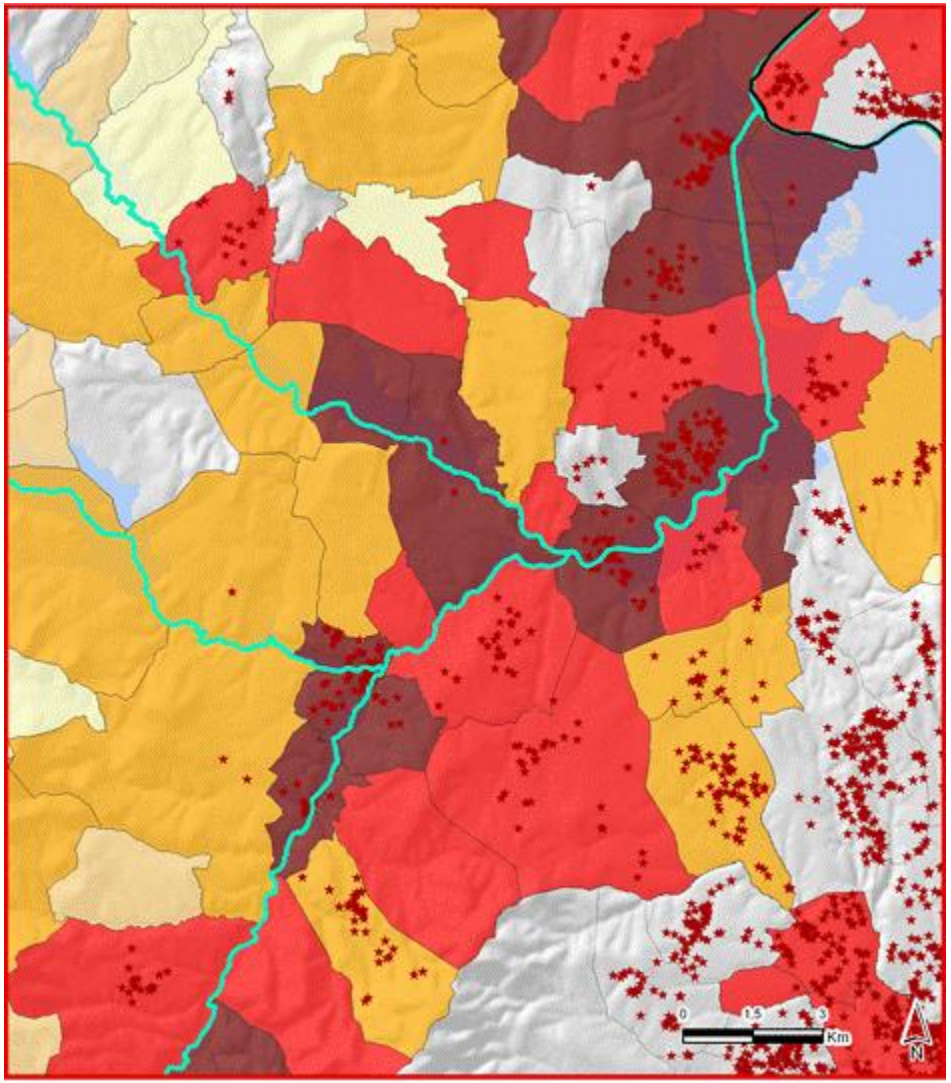


Hydrographic network

Insured risks

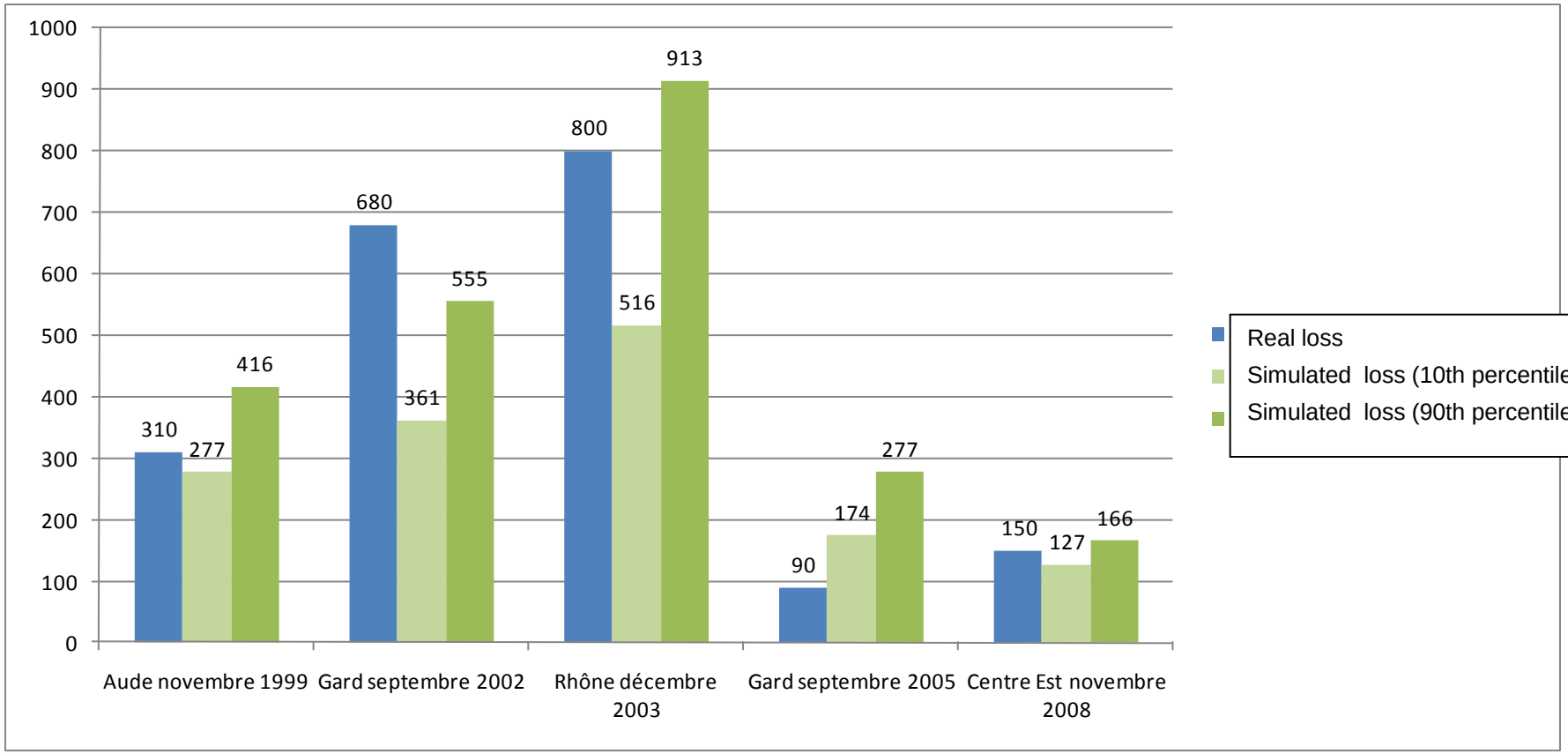
Costs per zipcode

Costs per zipcode (k€)

- < 5
- 5 - 20
- 20 - 60
- 60 - 190
- > 190

Deterministic model

Comparison between real and simulated damages for main flood events



* Loss for non-motor risks

From deterministic to probabilistic model

- Building a probabilistic model requires the creation of a stochastic event set of non-occured but realistic events. Two solutions have been chosen for flood :

  - Distribution of fictive river runoff events :

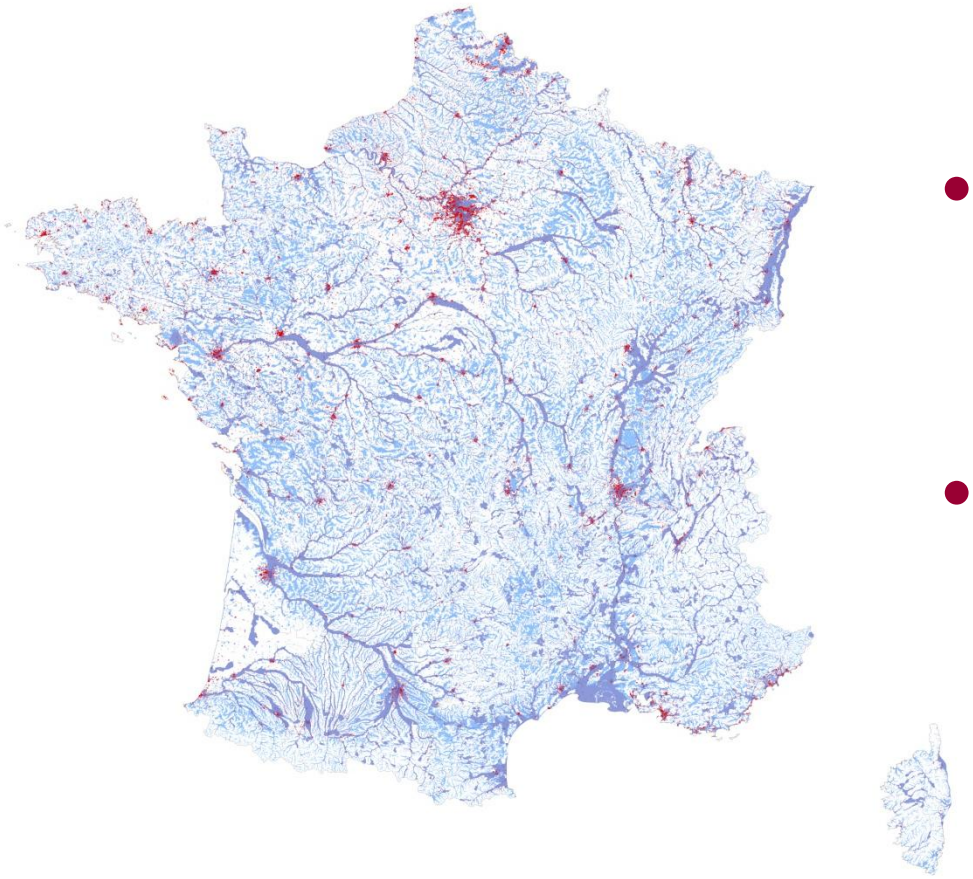
    → SCHAPI runoff database (Banque Hydro) ;
    → Statistical approach

  - Distribution of fictive rainfall events :

    → Météo France SAFRAN rainfall database : 52 years of hour precipitation on a 8 x 8 km grid for all metropolitean territory
    → Collaboration between CCR and IRSTEA for the development of a rainfall generator

French exposure to floods

Probabilistic map for flood risk



- CCR flood model simulates the two main kinds of hazard : river floods and Surface water flooding following heavy rainfall. There are both taken into account for damage modeling.
- Works are in progress for seasurge modeling.

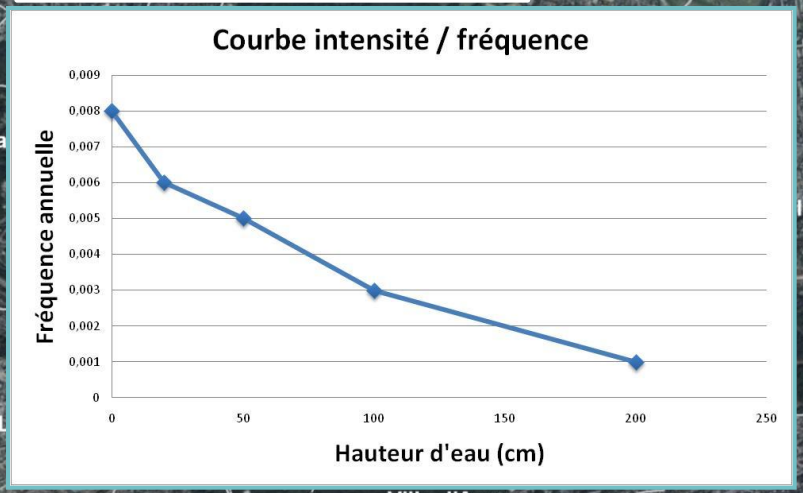
river floods

Surface water flooding

urban areas

Probabilistic map for river flood risk

On a 50 x 50 m grid

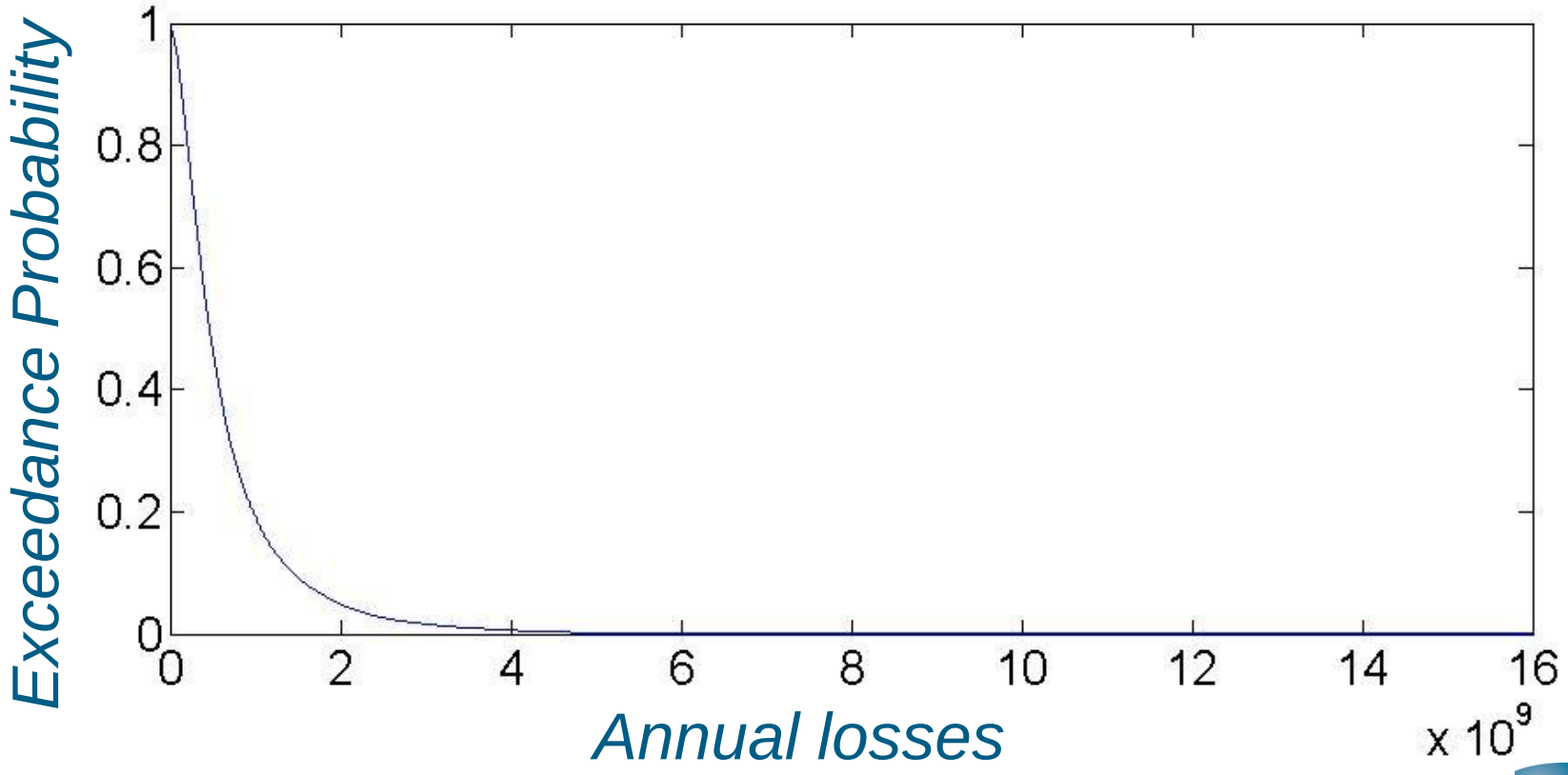


EP curves

- Annual losses estimation for the insurance market requires to create an Aggregate Probability Curves.

- This curve gives us the probability (or the return period) that the annual losses exceed a determined threshold.

Distribution of probable annual losses for river and pluvial floods.



Uncertainties of this study

- The limits of this study are the following :
  - The stochastic event set is not enough representative to show an exhaustive vision of floods in France
  - The historical depth of the runoff and rainfall data is limited : the use of historical data could correct this limit
  - The most extreme events are simulated by the runoff method (river flood only) thus the damage are underestimated (no pluvial flood)
  - CCR is still expecting a complete database of flood defenses
  - Aggravating factors like ground water elevation are not taken into account
  - Seasurge exposition are not yet taken into account in the event set.
  - Some data could be more accurate (DTM for exemple)
  - Risk address geocoding has to be improved
  - Insured values are not well known in France
  - Industrial risk modeling is an important source of uncertainties

The practical use of this study

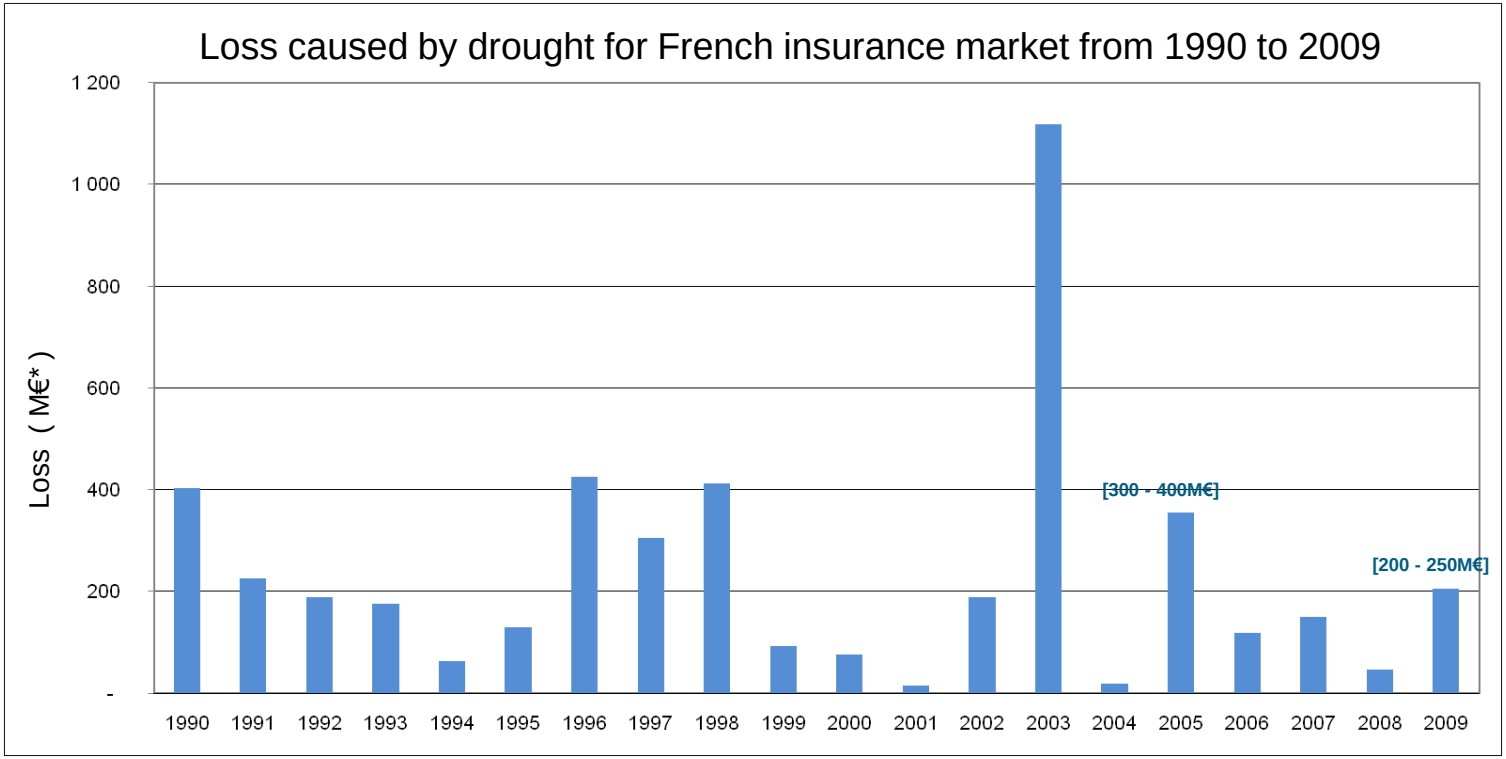
- This model can contribute :
  - To analyse the financial exposition to floods in France
  - To estimate the 200-year annual lost exposure for Solvency 2
  - This tool will be usefull for cost benefit analysis and preliminary studies for preventive actions

What do we call « Drought »?

- In the French compensation scheme for natural disasters, the subsidence due to shrink-swell clay and its effect to the Properties is usually called « drought ».
- A drought event is often represented by its year of occurrence.

Loss caused by drought for French insurance market from 1990 to 2009

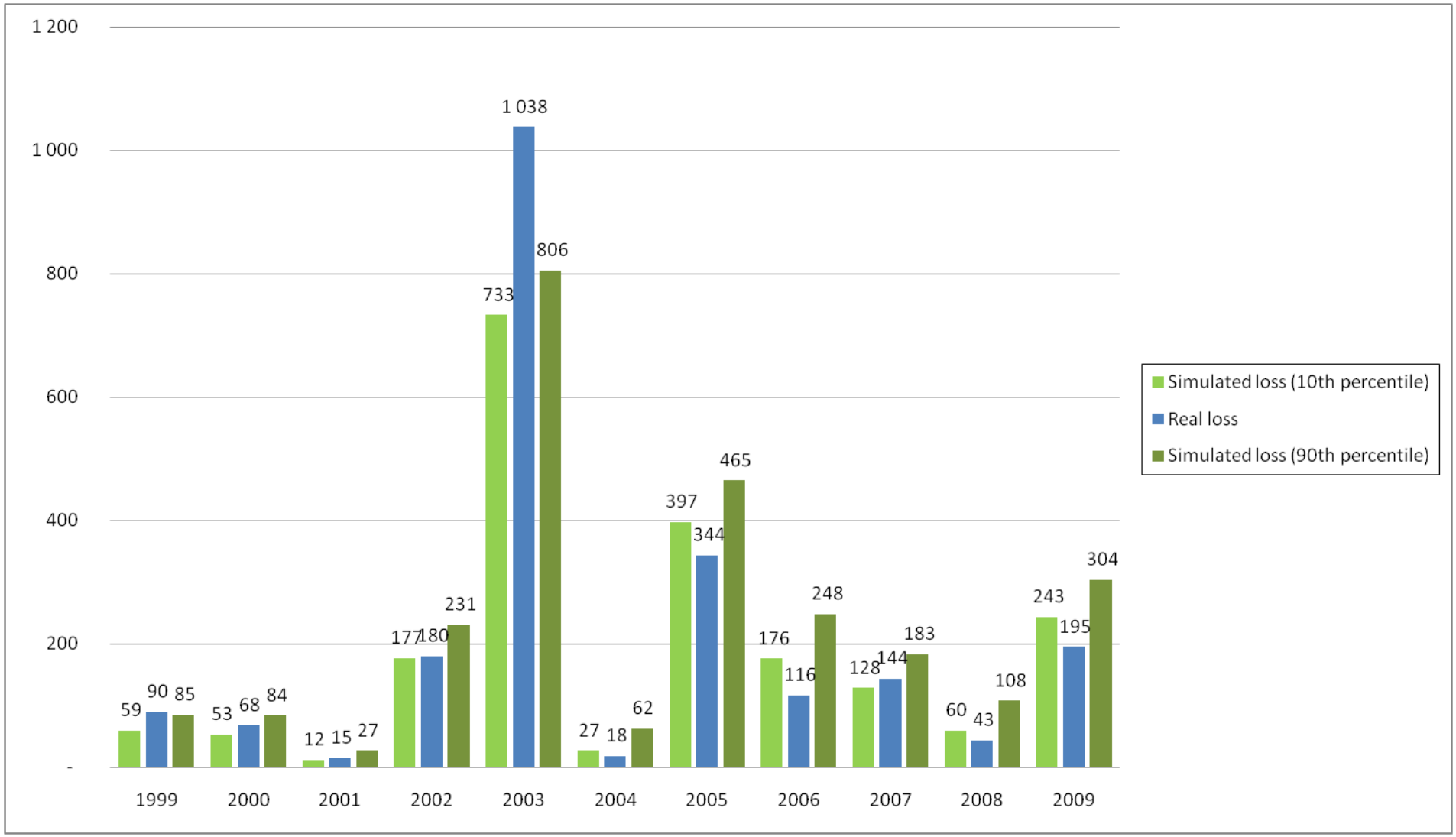
- We observe strong variations from a year to another.
- 2003 drought is the most expensive event since scheme creation: 1,1 billion euro (*) + 218 million euro (*) for exceptional proceedings.
- This peril has a long term developpement.



(*) *non updated*

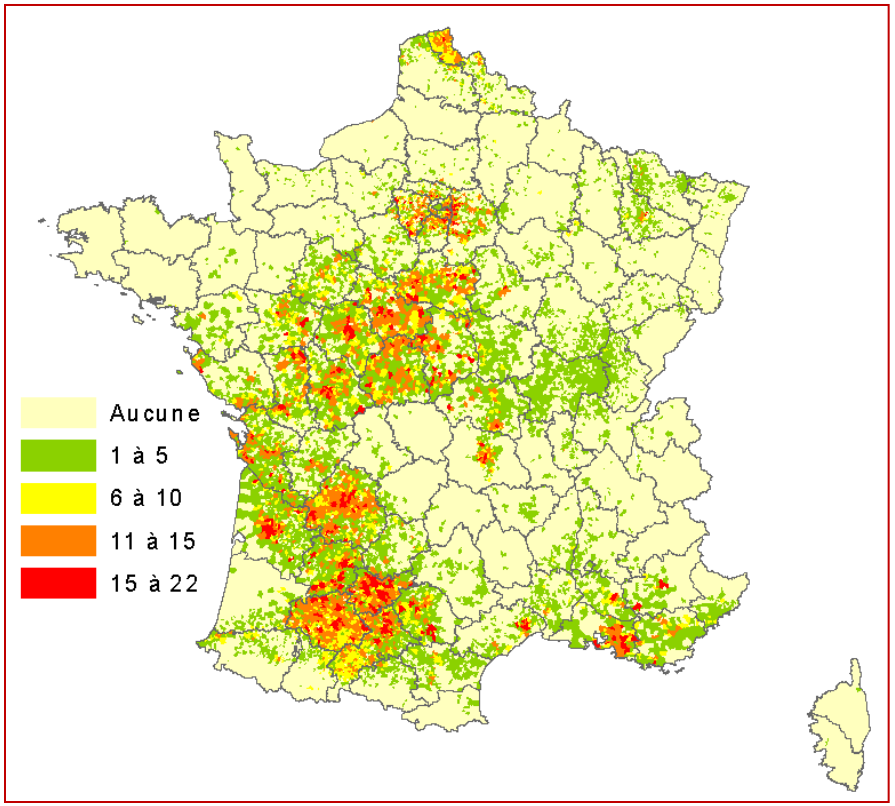
Deterministic model

Comparison between real and simulated damages for main drought events

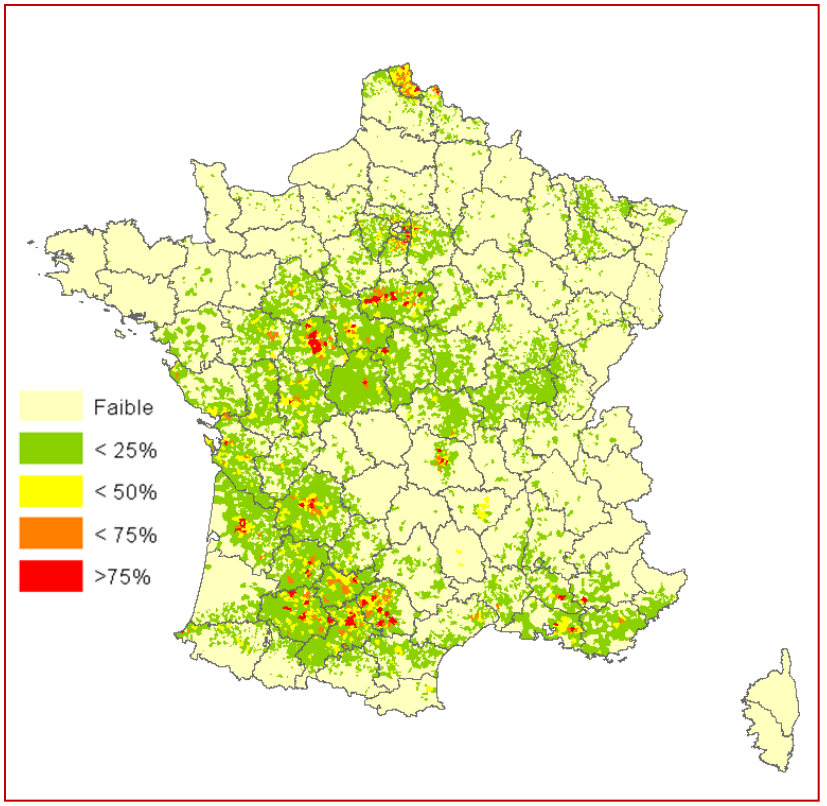


Probabilistic events simulation

Number of requests by commune since 1989



Request probability by commune for the 10000-events catalog



CCR earthquake modeled territories

- Since the end of 2008, CCR has been using RMS earthquake models to perform analysis on the most exposed French territories :
  - The French mainland area where the seismicity is moderate but the total sum insured (TSI) located within the most exposed area is quite important[1].
  - The four Lesser Antilles islands : Guadeloupe, Martinique, St Barts and St Martin where the TSI is < 1% of the overall TSI but the hazard is more frequent and more intense.

    Furthermore, both the population and the insurance coverage[2] of these Caribbean islands are on a high increasing rate and the expected loss related to earthquake grow year-over-year.

- The other overseas French territories are not modeled at CCR either because the earthquake threat is low[3] even if the exposure is not negligible (*i.e.* La Réunion island) or because the TSI is irrelevant regarding other territories (i.e. St-Pierre-et-Miquelon islands[4]).

[1] up to 900 bn€ TSI in the most exposed area of the French mainland (South-East, Alps and Pyrenees) vs. ~12,000 bn€ in 2011 for all the French territories, both evaluations include BI.

[2] Insurance coverage penetration : to date, only ~45 to 60 % of residential properties are covered by the Nat Cat compensation scheme whereas ~99 % of residential properties are covered in French mainland.

[3] see for instance the new French earthquake hazard map with the new mandatory building code

[4] TSI estimated to be ~0.35 bn€

CCR earthquake model improvements

- Since the very beginning, CCR has been in relation with RMS modelers in order to improve their models by taking more into account the French seismicity characteristics for both mainland and overseas territories.

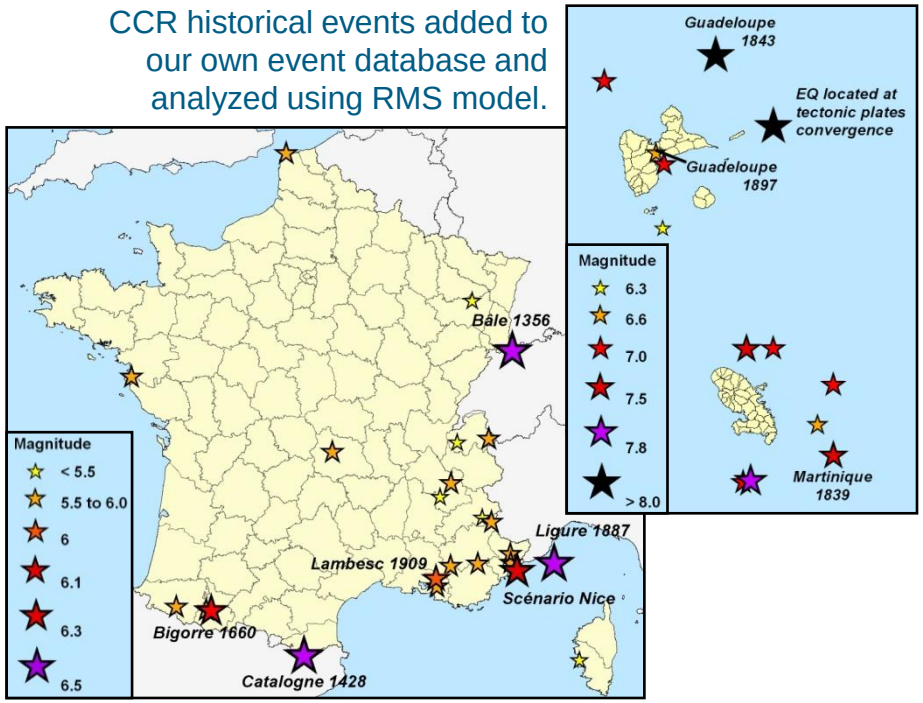
- CCR is also collaborating with the main French research institutes[1] focusing on earthquakes and covering the full spectrum of the model: hazard quantification, local site effects, buildings vulnerability and probabilistic damages.

➔ Thus, CCR deployed some post-analysis improvements including most of the knowledge gathered while working with the state-of-the-art research institutes.

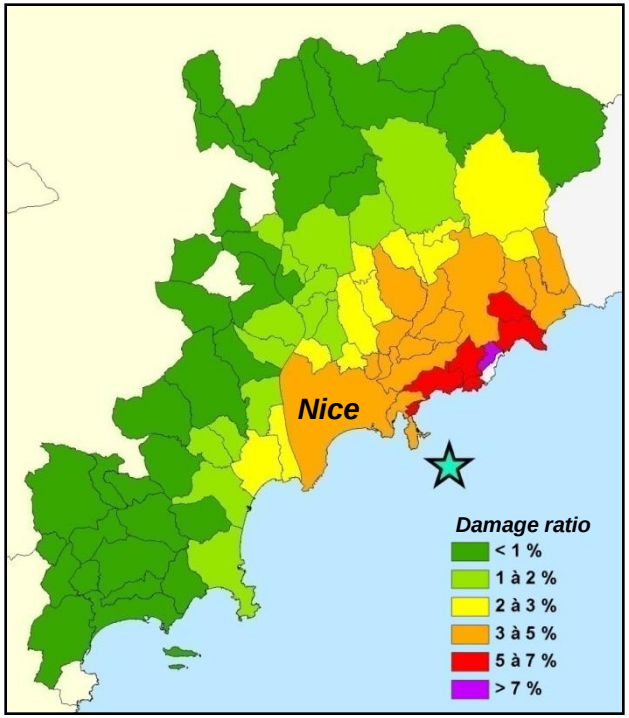
[1] either in close collaboration (BRGM : French geological survey) or in open-committees (CEA and ASN for the nuclear industry; OMP, EOST and IPGP : main universities laboratories working on earthquake).

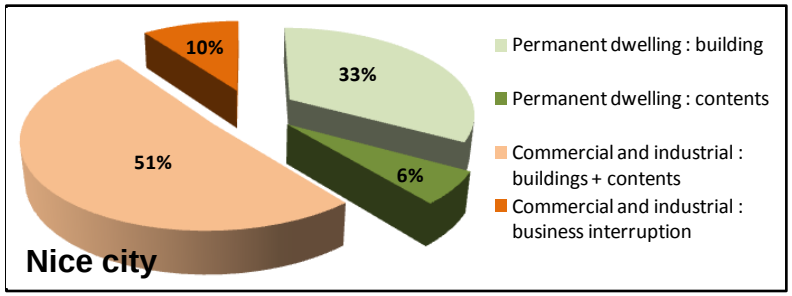
A few examples of CCR studies on earthquake

CCR historical events added to our own event database and analyzed using RMS model.



Specific event footprint at a city-scale resolution with insights on the loss by line of business and summary for the whole affected area (M_w=6.3 offshore Nice city).

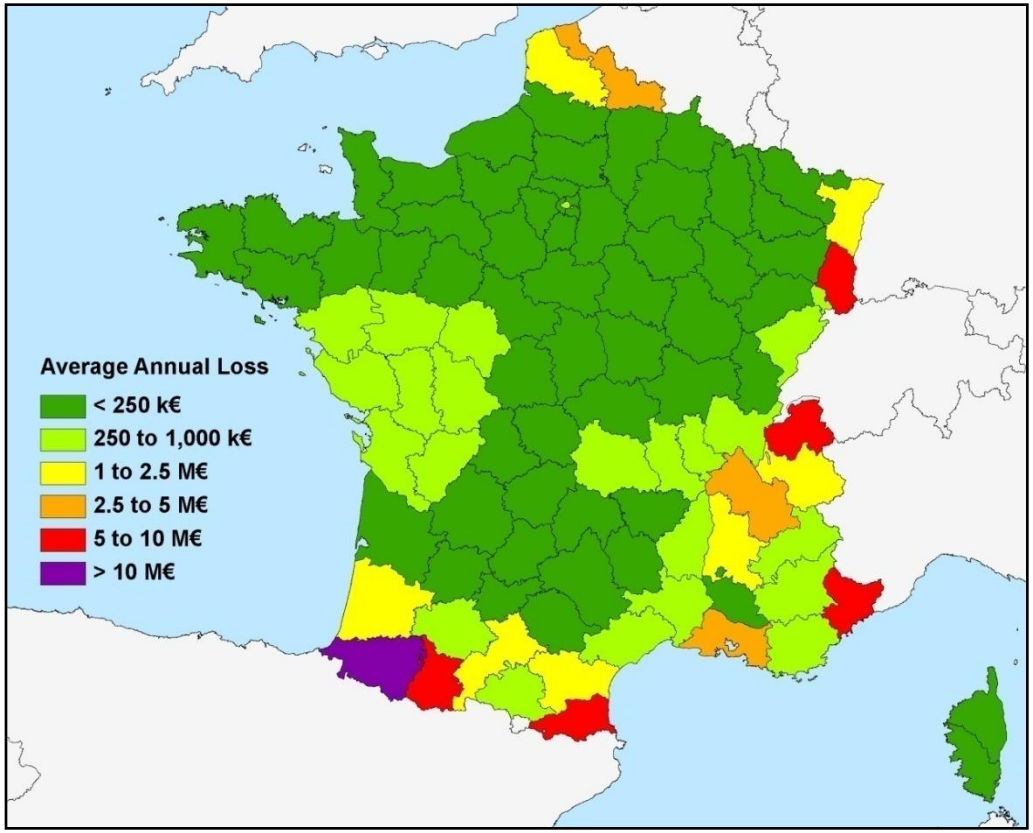


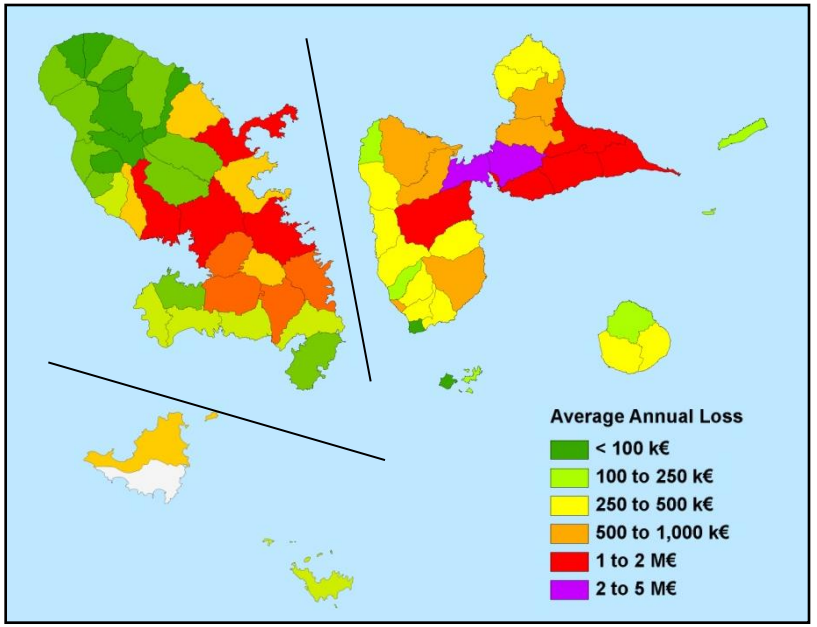


Event summary report	
Affected cities	82
# of risk exposed to event	690,819
Nat Cat premium exposed	20.4 M€
TSI exposed	324 bn€
Loss	**9.57 bn€**
Damage ratio	2.92 %

Average Annual Loss – CCR's estimation March 2012

Earthquakes : Mainland and Caribbean Islands





Average Annual Loss – CCR's estimation March 2012

Hurricanes : Caribbean Islands

- Since 2009, CCR has also been using RMS models to perform analysis on the Caribbean Islands Hurricanes Exposure.
- Insurance market losses for the historical events are compared with the results of RMS and the hazard mapping is analyzed.
- Other studies has been started this year on La Réunion, where RMS doesn't provide any model. This approach concerns floods, seasurges and winds occurring during a hurricane.