

EXPERTISE AND MODELLING



CCR AT THE HEART OF THE SCIENTIFIC ECOSYSTEM

CCR is a public reinsurer authorised to provide unlimited coverage to insurers for certain exceptional risks, in particular natural catastrophes, and terrorism. With regard to natural disasters, the main hazards covered are: floods, geotechnical droughts, earthquakes, coastal flooding and cyclones in the French overseas territories.

CCR develops hazard impact models in partnership with leading scientific organisations in France and Europe: Météo-France, INRAE and IFSTTAR for hydrological risks, BRGM and ENSG Nancy for geological risks. CCR invests in applied research by financing doctoral theses: on agricultural risks, with Agrocampus Ouest, on data sciences and applied mathematics, with Écoles des Mines de Paris, Nancy, Paris V and on seismic risk with ENSG Nancy. The risk of terrorism (consequences of CBRN explosions) is also modelled. In collaboration with the French Government, in 2020, forward-looking studies were also conducted on the pandemic and the operating losses resulting from the business lockdowns.

Main partners



AN OPERATIONAL MODELLING

All models developed at CCR are based on two approaches:

• The simulation of real events: damage estimates, hazard mapping and impact of prevention;

 The simulation of a catalogue of hypothetical events to assess the French territory's exposure to different hazards, to enable the calculation of the potential liabilities of CCR and its clients and for pricing purposes. The event intelligence implemented by CCR is an operational chain that provides a quick assessment of the damage after an event occurs. Monitoring and alert are carried out with **Météo-France** and a company called **Predict**. The modelling chain is based on several steps:

- The collection of real-time hazard data;
- The collection of information on the nature of the damage observed;
- simulation and carpwe mapping of insured damages with their estimate;
- publication within 5 days of an event.







Flood modelling in Southwest France in December 2019

DATA AND GEOLOCATION

To refine our knowledge of risks and claims, CCR has been collecting data from its insurance clients for over 15 years to better assess the exposure of the French territory to natural disasters. It does so with the insurance companies that adhere to the natural disasters public reinsurance scheme, under bilateral confidentiality agreements. This data relates to:

• the insured claims , located at the exact address or the municipality;

• losses that have occurred, located at the exact address or the municipality.

CCR has built up a database which, depending on the year, represents up to 90% of the market share for insured risks and up to 70% for claims. Enriched over time by crossreferencing with additional public data, it has enabled CCR to develop its knowledge and expertise in natural disasters in France.

Risk exposure indicators are thus developed and made available to insurers and public authorities through bilateral agreements. They help to prioritise prevention measures in certain areas and to assess their effectiveness.

In addition to the hazard data collected for the Nat Cat scheme, CCR is building a database on behalf of the French Ministry of Agriculture and Food on farmers who have taken out comprehensive weather insurance for their crops. This database makes it possible to monitor the growth of this insurance product. COLLECTION OF LOCALISED DATA ON INSURED RISKS AND CLAIMS

> Processing, geocoding and enhancement



Insurance indicators (S/P, claims frequency, etc.)



MODELLING THE FINANCIAL IMPACTS OF CLIMATE DISASTERS

For over 15 years, CCR has been developing Cat impact models for major climate hazards, including geotechnical droughts.

Since 2015, CCR has been developing an innovative multihazards modelling approach by coupling its models to an atmospheric simulation model (ARPEGE-Climate from Météo-France). Thus, the correlation between hazards is no longer a statistical hypothesis but the result of global climatics conditions.

The main hazards covered are the following:

• The flood model which simulates two phenomena: the surface runoff (pluvial flood) and the river overflow (fluvial flood) and their consequential damages;

• The modelling of geotechnical drought

(shrinkage and swelling of clay soils) is based on the use of a **Météo-France** indicator, the uniform Soil Wetness Index, geological indicators (clay content of the soil) and building characteristics. It is the second most costly hazard for the Nat Cat scheme;

• The coastal flooding model is used to estimate the impact of coastal flooding that may occur during storms. The model is based on three key steps: estimation of the tide and pressure setup, modelling of waves at sea and estimation of the impact of flooding on land;

• Cyclone modelling,

implemented in partnership with JBA Risk Management and RiskWeatherTech, it simulates the three phenomena (wind, flooding and coastal flooding) in the French overseas departments: The Antilles and La Réunion. This complex approach requires coupling a climate simulation model with a local impact model.

.... AND GEOLOGICAL HAZARDS

The deterministic part of the **earthquake model** was developed under a multiyear agreement with **BRGM**. A probabilistic earthquake generator is being developed ir partnership with **ENSG Nancy**. In addition, CCR is also developing models for risks other than climate risks: **nuclear liability and terrorism.**



IN A CONTEXT OF CLIMATE CHANGE

In partnership with Météo-France, CCR carries out studies on the impact of climate change on the risk exposure of territories. The modelling chain is based upstream on the use of meteorological data from Météo France's ARPEGE-CLIMATE model, which simulates 400 years of current climate and 400 years of future climate, by 2050, according to various IPCC scenarios.

These studies cover mainland France and the French Overseas territories. They are being extended to the consequences of extreme drought and overwhelmed water events on crop yields, as part of a thesis in partnership with **Agrocampus Ouest**.



Comparison of submerged land for a 100-year return period in the Châtelaillon-Plage area (Charente-Maritime, France)



Drought intensity according to the DOWKI meteorological index on the 2003





Average loss rates for soft winter wheat and meadows and quantiles (10-90) in relation to the meteorological index values on farming in France in 2003, a year of severe drought

Soft winter wheat Meadows

The more extreme the index values, the greater the crop losses. The index is correlated to yield losses. It is the extreme values of the index that are important to quantify in climate change simulations.

AT THE SERVICE OF PREVENTION

CCR models can be used to carry out cost-benefit analyses of prevention actions. Designed and tested in research projects, this application of the models provides additional analytical tools for preventionists and decision makers.

Modelling of the flood hazard. Comparison with historical claims experience.



CCR is improving its modelling and result-analysis techniques by using satellite images via remote sensing methods. Modelling now relies on data science methods, in addition to traditional tools, to improve its predictive capabilities and the analysis of its uncertainties.

In coverage, the Navier-Stockes equation is used to describe the flow of fluids, i.e. to determine its velocity field at any point in space

