White Paper

Climate-Coupled-Catastrophe Models™ (C3 Models™): Vital for Understanding Climate Risk

By

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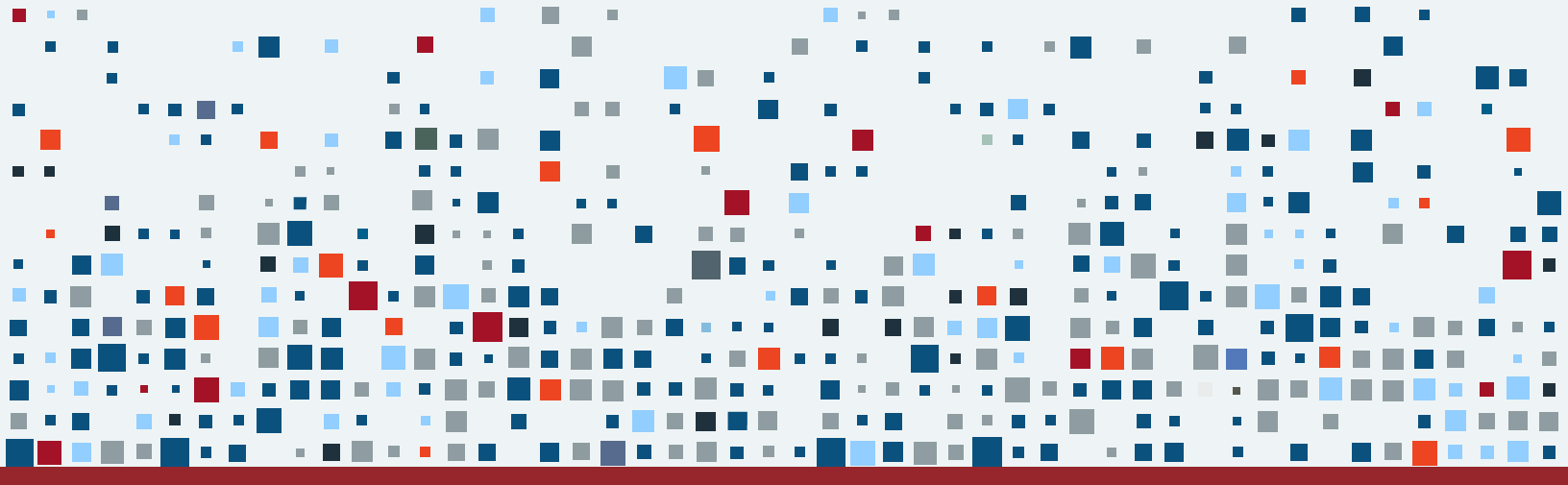
CoreLogic®



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Under climate change, future extreme weather events are expected to vary in their spatial distribution, frequency, and severity. While the physical principle underlying the conditions necessary for cyclogenesis (the intensification of storms such as hurricanes and winter bomb cyclones) will remain static, future weather patterns will be influenced by climate change. Therefore, it is imperative to consider both climate and catastrophe models to truly represent the future of natural hazards.

To be accurate, quality catastrophe models must be coupled with future climate models that use highly granular, dynamically downscaled data, tested across different regions and time periods. *Climate-Coupled-Catastrophe Models™ (C3 Models™) uses the most current science and data science available in the market today and incorporates future climate hazards, vulnerability models, and financial risk measures.*

Catastrophe (CAT) models have been widely used by financial, insurance, reinsurance, and government agencies for more than 25 years. Since their inception, CAT modeling has significantly improved in accuracy and sophistication as scientists learn from experience and develop innovative technologies and models.

CAT models are developed using the physical processes of natural events, historical data, and probabilistic modeling. A traditional CAT model consists of three main modules: a hazard module, a vulnerability module, and a financial module. These three modules are then integrated within a probabilistic framework (Figure 1).

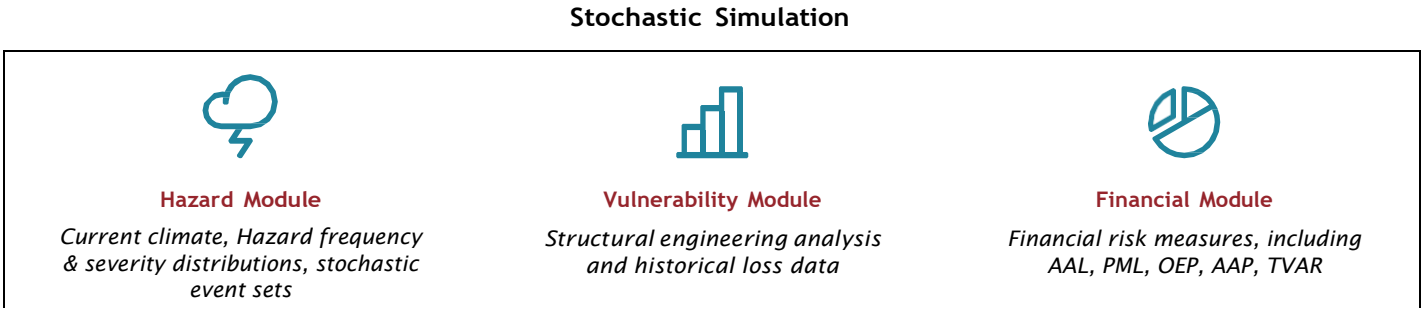

Figure 1. Main components of CAT models

AAL – Average Annual Loss
PML – Probable Maximum Loss
OEP – Occurrence Exceedance Probability
AAP – Aggregate Exceedance Probability
TVAR –Tail Value at Risk

Incorporating the latest scientific research, deep structural engineering knowledge, and a breadth of claims and exposure data, CoreLogic's CAT models produce a unique and innovative view of global catastrophe risk. Our models have been rigorously examined and benchmarked against recent climate events and claims data, with vast geographic coverage expanding six continents, 95+ territories, and 180+ models (Figure 2). These models are regularly updated using well-established and efficient methods, taking advantage of cloud computing and automation.

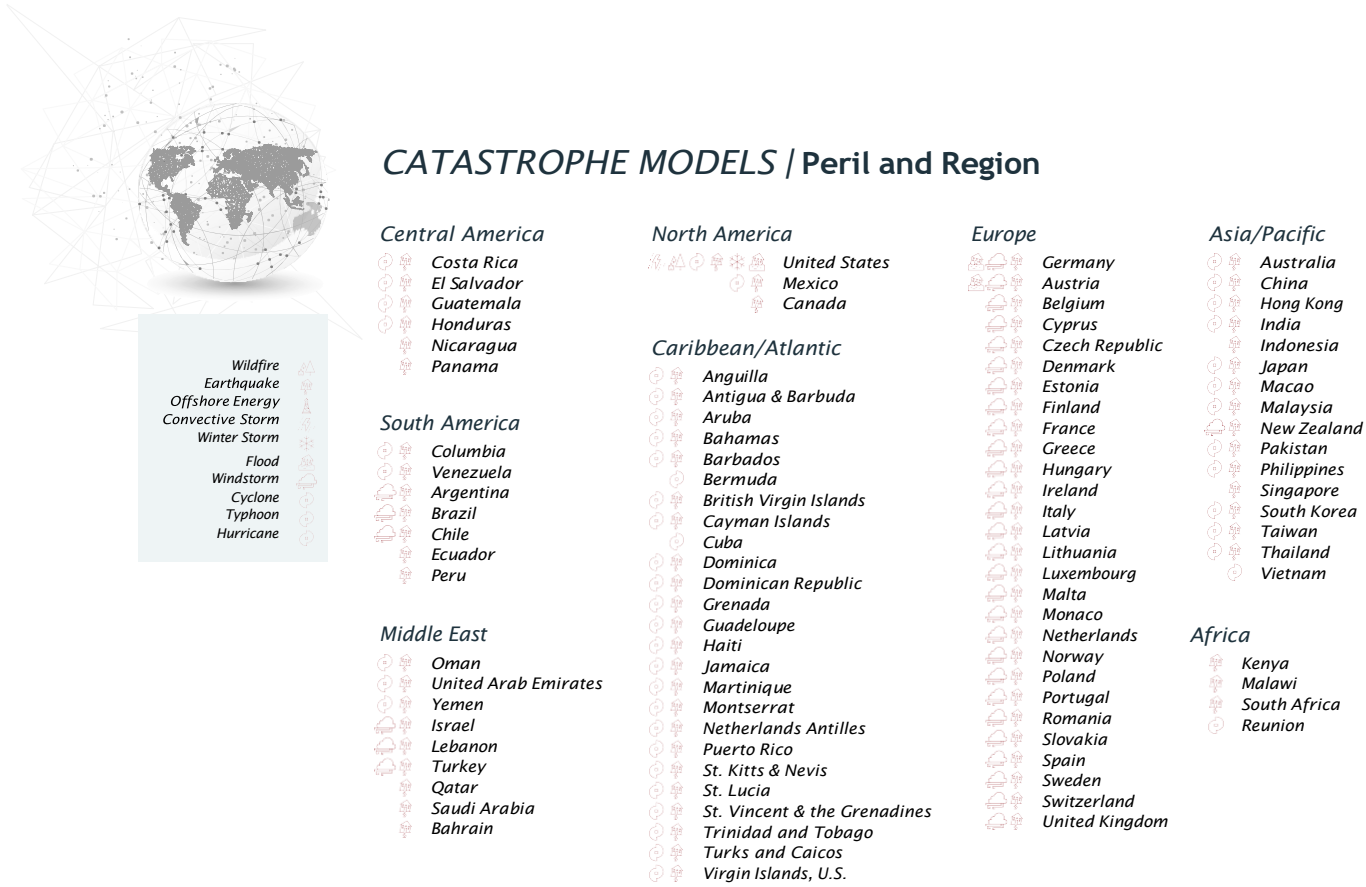

Figure 2. CoreLogic catastrophe models

Building accurate CAT models is complex. Historical events provide a valuable foundation, but they don't tell the whole story.

Gaps in sampling and observation in the short (<150 year) observational record require the simulation of weather events in addition to observed historical events. Catastrophe models, such as those developed by CoreLogic, simulate hundreds of thousands of years of weather events to capture a broader range of potential disasters. This approach reveals risks that might not be apparent from a limited historical record. Reliance on the observational record alone would underestimate risk.

CoreLogic released the first-of-its-kind Climate-Coupled-Catastrophe Models™ (C3 Models™) within the Intergovernmental Panel on Climate Change (IPCC) Coupled Model Intercomparison Project (CMIP5) framework which is capable of capturing highly granular property details along with future climate risk probabilities in previously unseen detail (Figure 3).

Figure 3. A detailed image of a property's risk from CoreLogic's CRA solution, using C3 modeling.

CoreLogic incorporates C3 Models™ into its solution, coupling best-in-class climate modeling with CoreLogic's third- generation, high-definition CAT models (Figure 4). Our Climate Risk Analytics solution includes comprehensive climate change physical risk that measures for wildfire, hurricane, storm surge, inland flood, severe convective storms, winter storms, and earthquake (earthquake-induced tsunamis and fire-following-earthquakes are also affected by climate change in our model). Our next Climate Risk Analytics release will include drought, heatwaves, and extreme precipitation.

Climate-Coupled-Catastrophe Models™ (C3 Models™)

Stochastic Simulation

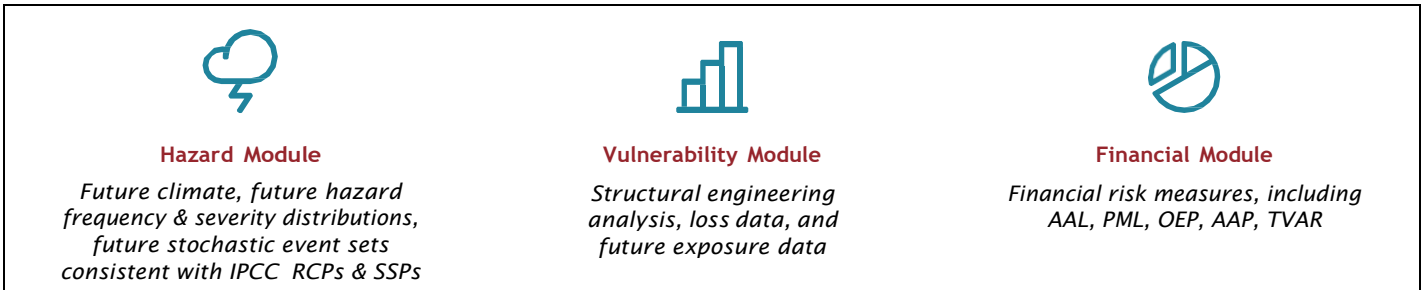

Figure 4. Main components of C3 Models

IPCC – Intergovernmental Panel on Climate Change
RCPs – Representative Climate Pathways
SSPs – Shared Socioeconomic Pathways
AAL – Average Annual Loss
PML – Probable Maximum Loss
OEP – Occurrence Exceedance Probability
AAP – Aggregate Exceedance Probability
TVAR – Tail Value at Risk

Like traditional CAT models, C3 Models™ consist of three modules: hazard, vulnerability, and financial, and include future risk scenarios under climate change.

Mapping the Effects of Climate Change With the C3 Models™ Hazard Module

The C3 Models Hazard Module defines the frequency and severity of the hazard associated with each peril. Using our Climate Risk Analytics solution, a stochastic event set is created to represent the entire spectrum of hazard frequency and severity consistent with future climate conditions.

CoreLogic is a leader in modeling extreme weather hazards under future climate scenarios. Our success is due in part to our consistent use of dynamical downscaled climate data that projects to higher resolutions. We use more than 200 climate variables to model peril-specific, physical process-driven future extreme events.

Using these high-resolution parameters, we model thousands of years of future events for each Representative Concentration Pathway emission scenario and time horizon to develop a comprehensive stochastic event set for future climate change scenarios. We follow this process for each of the perils included in our Climate Risk Analytics solution.

"Some of the early generation CAT models used what is known as a return period approach instead of the stochastic event set approach to model hazard frequency and severity. This approach, which may still be used by some newer climate risk companies, has significant shortcomings. It assumes the same return period risk happens at the same time. For example, this approach would model a 100-year flood depth that happens at the same time everywhere in the study area and usually ignores (or simplifies) correlations and uncertainty measures, which are essential for quantifying portfolio risk. This approach usually results in very unrealistic risk measures."

Mahmoud Khater, Ph.D.

Looking into the Future of Climate Change With the C3 Models™ Vulnerability Module

The second component of C3 Models is the Vulnerability Module. This module reflects the susceptibility of an asset to physical damage or business interruption. The Vulnerability Module requires a deep understanding of how various assets perform under diverse levels of hazard intensity and are peril specific.

The vulnerability functions in our CAT models are based on extensive loss data and detailed structural engineering analyses and take advantage of CoreLogic's vast building characteristics data to predict property-level damage accurately. We have enhanced and validated the models for over 25 years. In our climate risk solution, the vulnerability component can be adjusted to account for future construction practices and potential future building design code improvements.

Using Property Data to Calculate Risk With the C3 Models™ Financial Module

The third component of C3 Models is the Financial Module, which calculates different property-level risk measures, such as the average annual loss and the probable maximum loss, with consideration for any insurance or reinsurance policy in place for a property. CoreLogic measures the probability of default and loss-given-default for every property loan. Our Financial Module is one of the most comprehensive and accepted models in the market. To calculate aggregate risk measures (e.g., portfolio 100-year loss) the correlation and dependency between portfolio locations must be considered; this is an integrated part of the CoreLogic C3 Financial Model.

Creating Future Year Loss Tables (YLT) and Climate Risk Measures

The future stochastic event sets are integrated with the vulnerability and financial components discussed above using a 300,000-year stochastic simulation to produce YLTs for future scenarios and time horizons. From these simulations, we generate comprehensive future climate change risk measures.

Creating the YLT and risk measures for each of the nearly 200 million properties in the U.S. requires comprehensive property data. For this purpose, CoreLogic pulls from its deep data archive, which includes building information on nearly every U.S. residential property. We then build footprint geocoding, accurate replacement cost value, and detailed building characteristics. The property data represents today's built environment and has been expanded to represent future socioeconomic conditions using data from the IPCC AR6 project.

As the climate continues to change, we must embrace innovative approaches to understanding risk. By integrating climate projections into catastrophe modeling, we can better understand our future risks to prepare for the challenges that lie ahead. Using s Climate-Coupled-Catastrophe Models™ (C3 Models™) can help us make informed decisions, develop robust risk mitigation strategies, and adapt to our changing environment. These models can play a crucial role in helping us manage and mitigate the risks posed by future climate catastrophes.

About CoreLogic

CoreLogic is a leading provider of property insights and innovative solutions, working to transform the property industry by putting people first. Using its network, scale, connectivity and technology, CoreLogic delivers faster, smarter, more human-centered experiences, which build better relationships, strengthen businesses, and ultimately create a more resilient society. For more information, please visit www.corelogic.com.

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