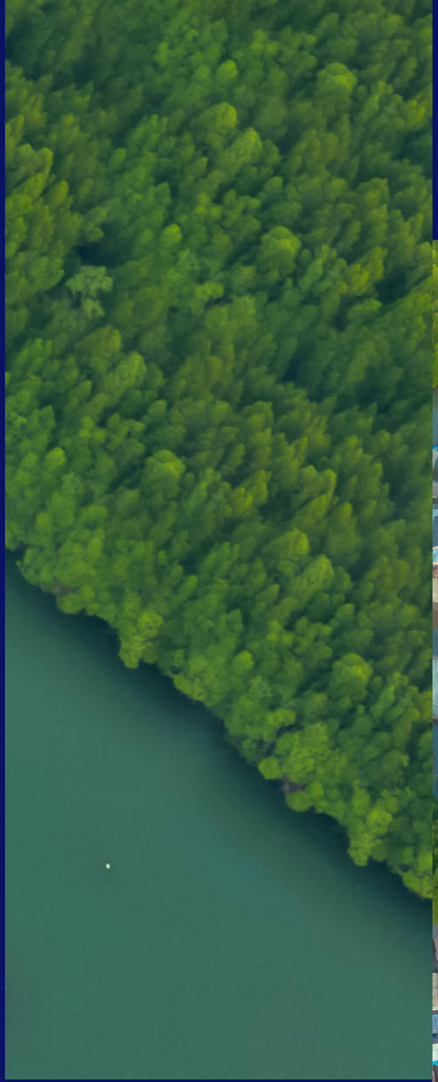
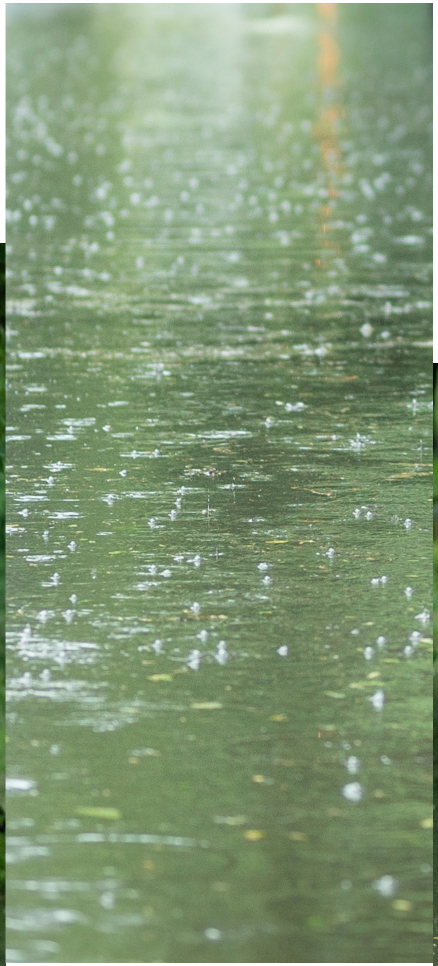
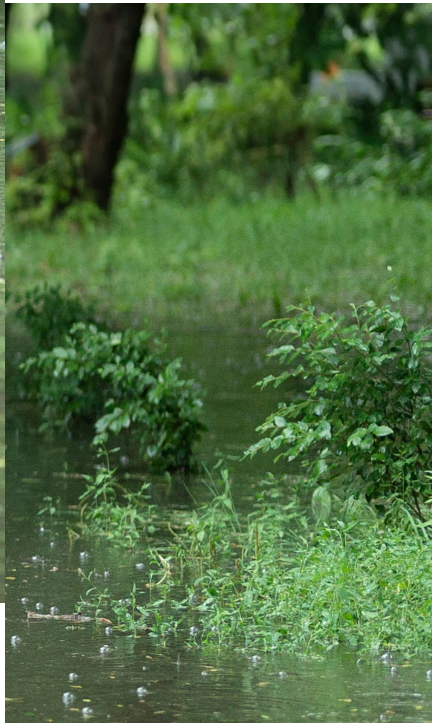
MOODY'S

# Five ways Moody's RMS™ High-Definition Modeling helps you understand flood risk



# Introduction

## FLOOD: HIGH INSURED LOSS, LOW INSURANCE PENETRATION

Flood is one of the major drivers of global insured catastrophe losses, with an estimated insured loss of US$99 billion over the last decade. However, despite the high insured loss, insurance penetration remains low: 83 percent of global economic loss from flood events is uninsured.[1]

The flood peril is multifaceted due to the hyperlocal nature of interactions between climate stressors and the built and natural environment. The degree of these interactions is generally shaped by trends in population dynamics, urbanization and flood mitigation strategies.

1 Bevere, L., & Remondi, F. (2022). Natural catastrophes in 2021: The floodgates are open. Swiss Re Institute, sigma 1/2022. https://www.swissre.com/dam/jcr:326182d5-d433-46b1-af36-06f2aedd9d9a/swiss-re-institute-sigma-natcat-2022-en.pdf

We introduced the first Moody's RMS™ Flood High-Definition (HD) Model in 2016 and have since expanded our portfolio to include 21 countries. The HD simulation-based flood framework represents a fundamental enhancement in producing realistic loss analytics including better modeling of cross-peril correlations.

The HD methodology empowers a wide spectrum of stakeholders – including the (re)insurance industry, governments, mortgage lenders, and financial services – to make informed decisions on portfolio management, risk management, and business planning. Our HD Models generate more transparent and accurate calculations, so organizations of all sizes can gain a competitive advantage by better understanding flood risk.

## WHY HIGH-DEFINITION (HD) MODELING?

HD Models are the newest generation of our probabilistic modeling suite. The HD model framework leverages cloud-based computing to enhance catastrophe model components and eliminate the need to make simplified assumptions.

Key Features of HD include:

- Temporal simulation of hazards and financial losses
- Proprietary exposure disaggregation methodology
- Ground-up loss calculations by sub-peril
- High spatial resolution
- And much more

# Unique Challenges of Flood Risk

**FLOOD MODELING'S COMPLEXITY STEMS FROM THE MULTIDIMENSIONAL FACTORS THAT MAY COMPOUND A FLOOD'S SEVERITY. JUST A FEW OF THESE INCLUDE:**

→ Types of flood risk, such as coastal, fluvial, and pluvial

→ Frequency and intensity of flood drivers, such as tropical storms and precipitation

→ Seasonality and antecedent hydrological conditions

→ Exposure resolution and primary building characteristics, such as the presence of basements

→ Characteristics of watersheds, terrain, and land use

→ Local flood mitigation strategies and preparedness

**FLASH**

Heavy or excessive rainfall causes rapid flooding of low-lying areas within minutes or a few hours (typically less than six hours)-also possible with a sudden release of water from a levee/dam (failure), ice jam, or other debris

**PLUVIAL/SURFACE**

Overland flow from rainfall runoff that is not absorbed or routed for drainage that flood low-lying areas or impermeable urban surfaces

**COASTAL/STORM SURGE**

Low-pressure weather systems over the ocean elevate sea levels above the normal tidal limit and flood areas of lower elevation near the coast, often exacerbated by heavy rainfall and onshore winds

**BACKWATER**

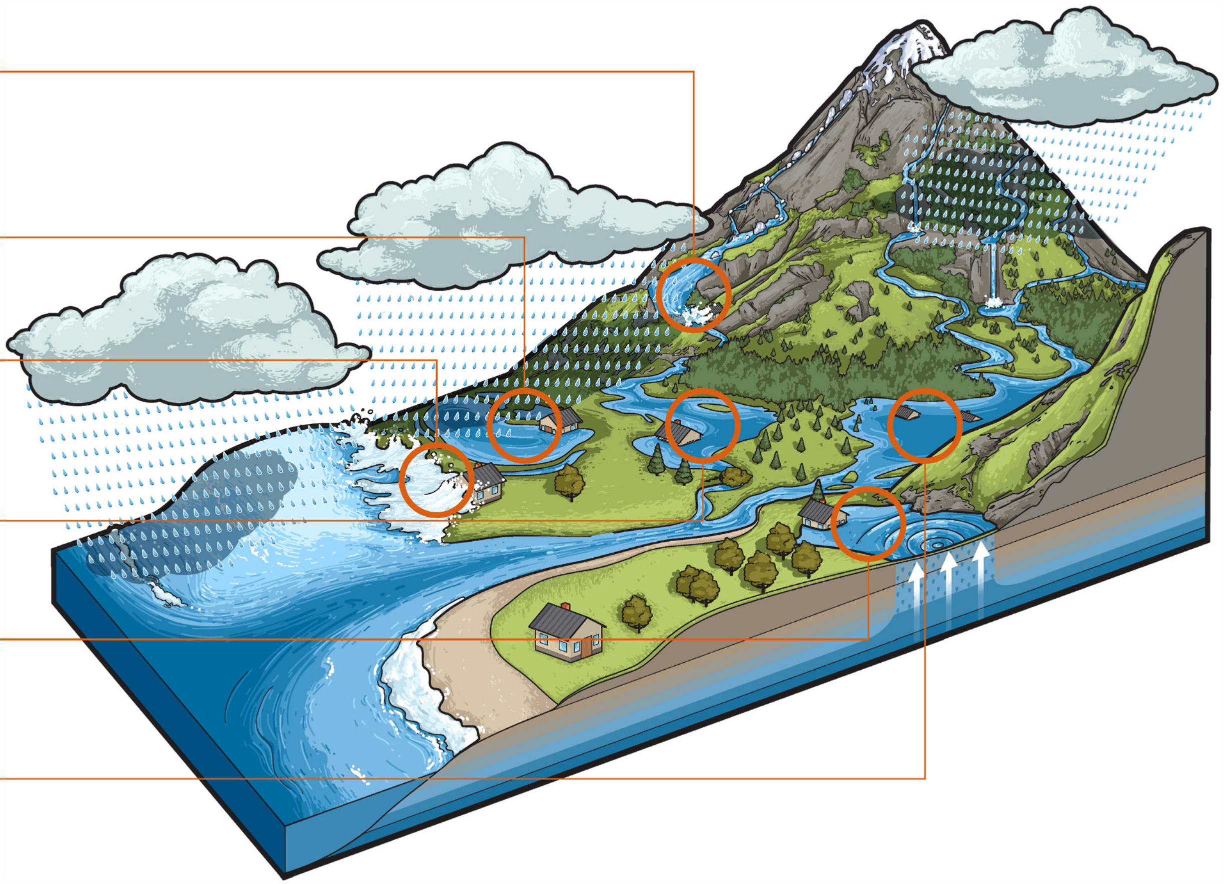
*Upstream* flooding caused by *downstream* conditions, such as channel restriction and/or high flow at a confluence of streams

**GROUNDWATER**

Underground water levels rise above normal and approach the surface, usually caused by prolonged periods of rainfall, which can last for several weeks or months

**FLUVIAL/RIVERINE**

Excessive rainfall/snowmelt over an extended period of time cause a river to exceed its capacity and overtop its banks



## Five ways HD Models quantify flood risk

**Let's explore how the Moody's RMS HD-modeling framework helps you address the unique characteristics of flood risk – so you can confidently take on more risk.**

1. Overcome gaps in exposure data

2. Understand the impact of antecedent conditions

3. Quantify post-event loss amplification

4. Incorporate special policy and treaty conditions into pricing decisions

5. Write policies that define the unique drivers of losses from sub-perils

1.

## OVERCOME GAPS IN EXPOSURE DATA

In many regions around the world, flood exposure data is only available at aggregate or low resolution, meaning a building location is within a provided resolution or aggregation, such as postcode zone, but the exact location is unknown. For perils with high hazard-gradients like flood, this uncertainty can lead to poor flood risk assessment.

To address this, Moody's RMS HD Models feature sophisticated approaches ensuring you can access high-quality flood risk analytics even with coarse or poor exposure data. To demonstrate, we analyzed ground-up losses using the Moody's RMS™ Europe Inland Flood HD Models across a commercial portfolio of 1,000 industrial risks. We ran the portfolio with coordinate-level data and then artificially degraded it to postcode level. Next, we ran the same experiment with a non-HD model for the same peril (Figure 1).

We found that differences between coordinate-level and postcode-level exposure data are significantly less with the HD model than with the non-HD model, as seen when comparing the two curves in Figure 1. Our HD Models improve results by more accurately capturing event losses for individual locations, as compared to aggregating hazard for locations with low geocoding, which is the approach chosen in non-HD models.

For (re)insurers and brokers alike, the HD Model results can have an enormous impact on your pricing practices. With greater confidence in flood risk assessments, you'll have greater flexibility to price more competitively in the market.

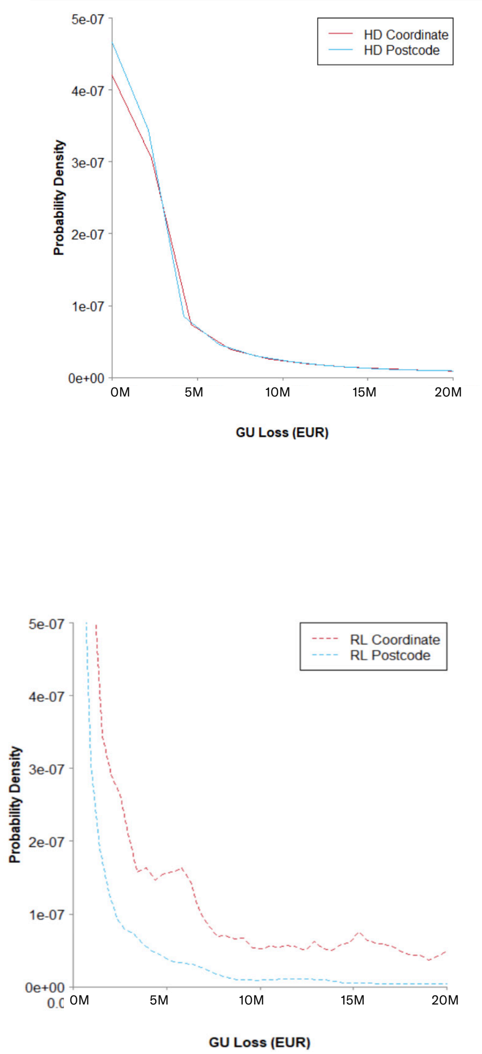



**Figure 1:** Probability density of (a) HD and (b) non-HD Model ground-up event losses across full event sets for a portfolio of 1,000 industrial risks geocoded to both coordinate- and postcode-level resolution

## HANDLING OF LOW-RESOLUTION EXPOSURE

Moody's RMS HD Models introduce sophisticated methodologies to handling aggregate and low-resolution exposures. Instead of aggregating the hazard, which leads to sub-optimal results, HD models are leveraging the models' hazard information at the native model resolution, in combination with high-resolution exposure distributions. Overall, this results in much more realistic and robust loss estimates across all exposures' typical spatial aggregation levels.

## CRITICAL FOR A ROBUST MODEL

Moody's RMS HD Models utilize a temporal simulation framework that explicitly models the time dependencies of events, including seasonality and antecedent conditions.

To address the complexity of antecedent conditions in our HD modeling, we had to think holistically and innovate to ensure that all sources of flood risk could be captured. Both meteorological and physical factors affect flood risk – from the intensity, frequency, and duration of rainfall to the type of soil and vegetation, and more.

Antecedent conditions are built into the modeling approach of all the Moody's RMS Flood HD Models. The analysis of antecedent conditions forms just one integral part – but a crucial one – of a robust modeling framework. A more realistic view of risk helps establish the full potential of extreme events including the potential exacerbation effects from by antecedent conditions.

# 2.

## UNDERSTAND THE IMPACT OF ANTECEDENT CONDITIONS

Antecedent conditions, such as rainfall events, snowmelt, baseflow conditions, and watershed characteristics, can have a significant impact on the severity of a flood event. Elevated levels of either antecedent soil moisture or river water levels can compound flood impact and, in certain cases, contribute to pushing a flood into a tail risk event.

The impact of antecedent conditions can range from no increase in potential losses in some zip codes to more than 200 percent in other zip codes. In 2021, high soil moisture conditions resulting from Tropical Storm Henri exacerbated the flood impacts of Hurricane Ida across the U.S., but the effects were not linear or evenly distributed across geographies. Imagine that soil is like a sponge. While a dried-out sponge takes a while to loosen up and absorb water, an already-saturated sponge is little help with a new spill.

# 3.

## QUANTIFY POST-EVENT LOSS AMPLIFICATION

After a major flood event, claims costs can exceed the normal settlement due to economic demand surge, disruption from heavy damage to urban infrastructure, social and claims inflation, operational factors, and compounding of events. In fact, compounding of events is an important element enabled by the temporal simulation in HD Models.

Compounding of events is considered of high importance for a peril such as flood. Multiple catastrophes occurring close in space and time can create additional cost increases due to the cumulative impact.

Post-event loss amplification (PLA) is nothing new to the industry. Yet, most catastrophe models do not account for compounded losses from multiple consecutive events. During successive catastrophes, a combination of internal and external factors can make claims more expensive.

Internal factors – such as an insurer's staff bandwidth to analyze and process claims – can result in higher travel costs for adjusters or expedited claims payouts. External factors – such as supply chain disruptions, inflation, or worker shortages – can dramatically impact the cost of the risk.

By utilizing a time-based simulation framework, HD modeling considers the residual effects of the earlier event when calculating the PLA factors for the later event and incorporates these different factors into key metrics, such as average annual loss and the exceedance probability curve. So you can easily account for multiple tail risk events.

# 4.

## INCORPORATE SPECIAL POLICY AND TREATY CONDITIONS INTO PRICING DECISIONS

Whatever side of the cedant relationship you are on, hours clauses are a staple in reinsurance contracts. The relationship between time and flood losses is nonlinear, as illustrated in Figure 2. If you were to rely on historical claims data or actuarial models to apply hours clauses for pricing, that would introduce a new view of risk – one that could likely diverge from your reference view.

Robust time-based flood analytics help (re)insurers and brokers balance competitive risk pricing with reducing exposure for tail risk events. Accurately applying the hours clause can improve your understanding of which terms and conditions are most suitable. Yet, many flood models do not account for time-based conditions.

The HD temporal simulation allows modeling of special policy and treaty conditions such as hours clauses and multiyear contracts. Hours clause is modeled with a physically-based approach which quantifies portfolio-specific temporal evolution of flood loss occurrence by event. With this unique view of risk, cedant teams can have a much better understanding of flood risk across multiple scenarios, price more competitively, and take on more risk without compromising risk thresholds.

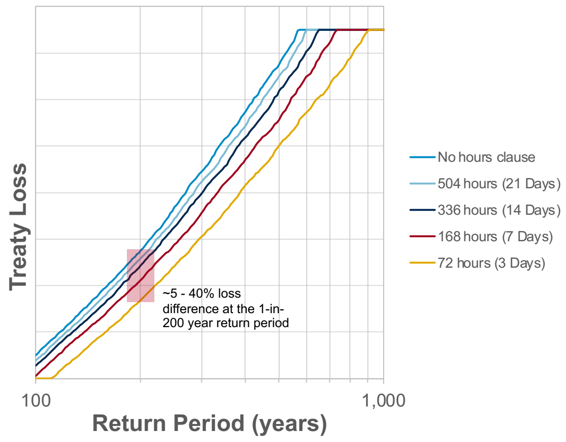



**Figure 2.** Sensitivity to different hours clauses based on treaty losses attaching around the 1-in-100 year return period loss. The impact becomes larger at higher return periods, however, results are highly dependent on the specific portfolio and policy terms applied.

# 5.

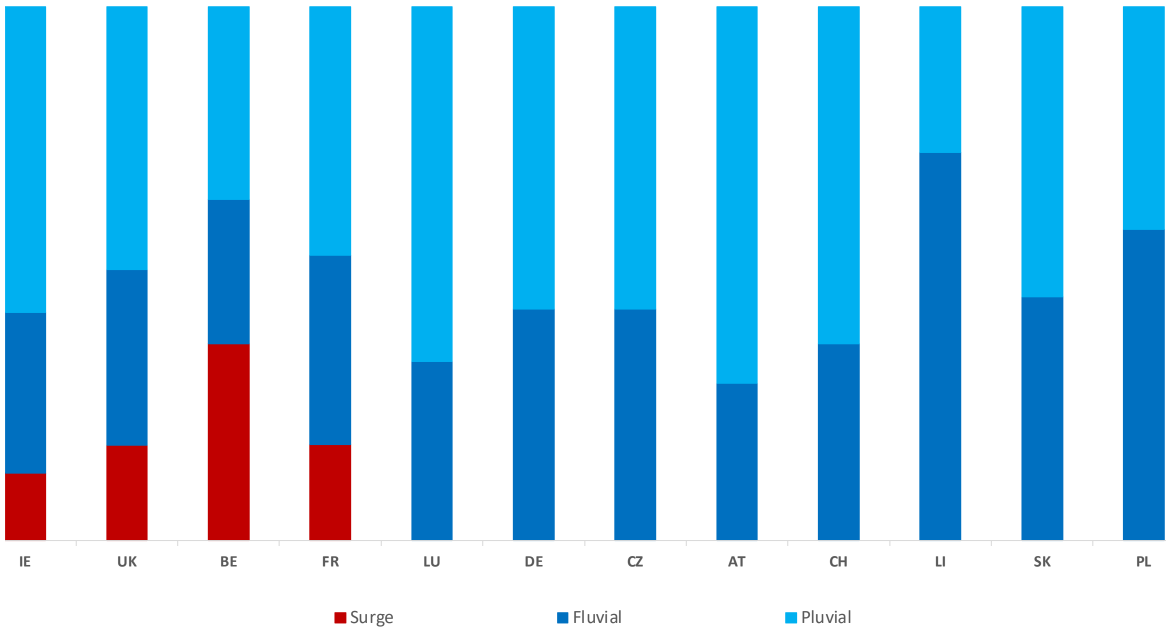
## WRITE POLICIES THAT DEFINE THE UNIQUE DRIVERS OF LOSSES FROM SUB-PERILS

Flood models can have multiple sub-perils, including inland flood and storm surge. Models must account for the possibility of overlapping damages for the same location and coverage. In an extreme event, the total damage for all the sub-perils could add up to more than 100 percent damage.

The sub-peril aggregation module, available in all flood HD models, defines the rules for how the model adjusts losses for each sub-peril – to distribute the potential damage across the sub-perils for each coverage type.

These rules are different for each model; for example, in the Moody's RMS™ Japan Typhoon and Flood HD Model, the modeled sub-perils include wind, inland flooding, and coastal flooding and each cause loss separately to enable users to extract wind-only, typhoon-driven inland flood-only, and coastal flood-only losses if desired.

**FLOOD RISK LANDSCAPE ACROSS EUROPE, EXPRESSED AS PROPORTION OF GROSS LOSS COST**




> “ **Models must account for the possibility of overlapping damages for the same location and coverage.”**

# Moody's Flood Risk Modeling builds on more than 20 Years of R&D

The Moody's RMS HD framework represents a major step forward in the quality of flood risk quantification. Over the course of the last 20 years, Moody's invested heavily in building a world-renowned flood model development team, enhancing modeling capabilities including HD modeling, and creating a global coverage (Figure 3).

Since the first Moody's flood model was pioneered in the early 2000s, Moody's has continuously improved coverage, quality of data, and physical representation of processes. Models leverage datasets from many sources including historical events, client claims data, and Moody's RMS in-person reconnaissance visits. Today, the newest generation of Moody's RMS Flood Model products and hazard maps cover 100% of global property gross written premiums.

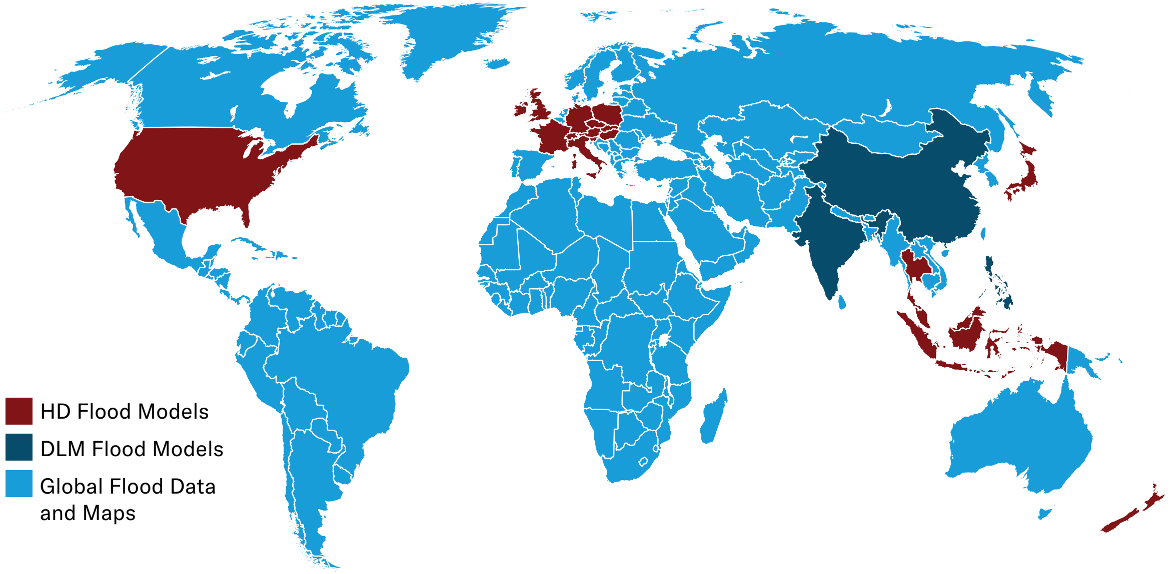



**Figure 3:** Coverage of the Moody's RMS Global Flood Models and Data

**If you would like to learn more about Moody's RMS High Definition Models or about specifics of modeling flood risk, contact your sales representative.**

Resources to explore now:

Global Flood Solutions Suite

Webinar Series: Season of Flood

Introducing Global Flood Solution Suite: Manage All Your Flood Risk on One Cloud Platform

Modeling the Perfect Storm: How Antecedent Conditions Can Compound the Severity of Flood Tail Risk Events

## ABOUT INSURANCE SOLUTIONS FROM MOODY'S

Moody's shapes the world's view of risk for insurers, reinsurers, financial services organizations, and the public sector, with Moody's Models underlying the nearly $2 trillion USD Property & Casualty industry. We empower organizations to evaluate and manage global risk from natural and man-made catastrophes, including hurricanes, earthquakes, floods, climate change, cyber, and pandemics.

Our unmatched science, technology, and 300+ catastrophe risk models help (re) insurers and other organizations evaluate and manage the risks of natural and man-made disasters. Leaders can address the risks of tomorrow with the Intelligent Risk Platform™, the only open cloud with collaborative applications and unified analytics that can power risk management excellence across organizations and industries.

Today's risk professionals trust Moody's to help them manage and navigate the risks of natural and man-made catastrophes.

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