Global Modeled Catastrophe Losses

SEPTEMBER 2019

AIR
A Verisk Business

Contact Information

If you have any questions regarding this document, contact:

AIR Worldwide Corporation
131 Dartmouth Street
Boston, MA 02116-5134
USA

Tel: (617) 267-6645
Fax: (617) 267-8284

Table of Contents

Introduction

Every year since 2012, AIR Worldwide (AIR) has published a report on extreme event risk from a global perspective.[1] This global risk profile is assessed by way of AIR's global industry exceedance probability (EP) curve, which puts into context years with high insured losses such as 2011 and 2017.[2]

The year 2019 opened with an M6.7 earthquake in Coquimbo, Chile, on January 19 (local time), which was followed by four more strong earthquakes in the Americas: the M8.0 Lagunas, Peru, earthquake in late May; the M6.2 Aserrio de Gariche, Panama, earthquake, in late June; and two earthquakes that struck Southern California only 34 hours and ~7 miles (11 km) apart in the first week of July—the M6.4 Searles Valley foreshock and the M7.1 Ridgecrest mainshock. Though the insured losses were limited, the Ridgecrest quake was the strongest to strike the State of California in 20 years, since the Hector Mine quake of October 16, 1999. The last earthquake to cause major destruction in the region was 25 years ago, the M6.7 Northridge earthquake of 1994.

The month of March brought one notable European winter storm, Eberhard, among a cluster of storms that struck in the first half of the month, including Freya/Bennet, Laura/Cornelius, and Dragi, which collectively affected the UK, Western, Central, and Northern European countries. In the second half of March and late April, the first two of three record cyclones to form in the Indian Ocean basin struck: Idai and Kenneth made landfall in Mozambique six weeks apart, both with the intensity of a major hurricane on the Saffir-Simpson Scale. Idai caused severe flooding, the worst in Mozambique since Cyclone Leon-Eline struck in 2000.

On May 3, Cyclone Fani made landfall in Odisha state in northeastern India with an intensity equivalent to a strong Category 3 hurricane. Fani was the strongest cyclone recorded in the state since the Orissa super cyclone of 1999 (Odisha was known as Orissa state until 2011). The major difference between the impact of the two cyclones lies in the preparations: Indian authorities evacuated 1.2 million people from high-risk areas ahead of Fani, and the death toll was 64, with Puri recording the majority of deaths, according to official Odisha government estimates; no such mass evacuation was conducted ahead of the Orissa 20 years ago, and more than 10,000 people lost their lives as a result.

In June, both Japan and China had one impactful earthquake each: the M5.8 Changning and the M6.4 Tsuruoka, respectively. Earlier in the year, the Philippines experienced two significant earthquakes within about 24 hours of each other in late April. The Japan and

---

[1] "Taking a Comprehensive View of Catastrophe Risk Worldwide: AIR's Global Exceedance Probability Curve," "AIR's 2013 Global Exceedance Probability Curve,", "AIR's 2014 Global Exceedance Probability Curve," "2015 Global Modeled Catastrophe Losses," "2016 Global Modeled Catastrophe Losses," "2017 Global Modeled Catastrophe Losses," and "2018 Global Modeled Catastrophe Losses."

[2] Catastrophes in 2011 include the Tohoku earthquake in Japan, major severe thunderstorms across the U.S., earthquakes in New Zealand, and floods in Thailand; catastrophes in 2017 include major severe thunderstorms across the U.S., HIM events, Mexico earthquakes, and California wildfires; catastrophes in 2018 include hurricanes Michael and Florence, Typhoon Jebi in Japan, the Western Japan Floods, and California wildfires.

Philippines quakes, as well as the aforementioned Chile quake, serve as reminders that these countries are located in one of the world's most seismically active regions. The Circum-Pacific Belt—or as it is more popularly and more colorfully known, the "Ring of Fire" —is an inverted horseshoe that follows the boundaries of the Pacific Ocean for 40,000 km (24,900 miles). It is a seismically active belt punctuated with more than 450 active volcanoes, tectonic plate boundary faults, and 90% of the planet's earthquakes. Quakes in this region are capable of being much worse.

In mid-July, Hurricane Barry struck Louisiana west of New Orleans as a barely Category 1 storm, bringing only light rain to a city that had feared much worse. Rainfall amounts elsewhere in the state fell short of what was forecast and did not come near the total precipitation accumulations of hurricanes Harvey and Florence, which were measured in feet not inches. Barry was notable for the record rainfall amounts it brought to the inland State of Arkansas, however, with the City of Dierks in Howard County receiving 16.17 inches of rain, surpassing its 24-hour rainfall record of 13.91 inches set in 1989 when Tropical Storm Allison impacted the area. Other locations in the state set records with lesser amounts. Barry is a reminder that managing U.S. hurricane risk is important for inland states as well as coastal ones.

Throughout 2019, many Asian countries—among them Bangladesh, China, India, Indonesia, Japan, Malaysia, Nepal, Pakistan, Philippines, and Vietnam—have experienced severe flooding at least once this year.

In November of last year, a California wildfire, the Camp Fire, caused the highest insured loss in 2018. It was the most destructive wildfire in California's recorded history, not only surpassing the record the Tubbs Fire set in October 2017 but more than tripling the number of structures Tubbs destroyed; it was also the deadliest. It is too early to know what the 2019 wildfire season will bring and whether it will be similar to those of 2018 and 2017.

Preparing for large losses *before* they occur is critical to continued solvency and resilience. There is still much of 2019 left, leaving open the possibility that a natural catastrophe could cause significant insured losses. In 2018, the top three insured losses globally were caused by events that occurred after September 1: Camp Fire (1), Hurricane Michael (2), and Typhoon Jebi (3).

The 2019 edition of AIR's white paper "Global Modeled Catastrophe Losses" bases its global loss metrics on AIR's latest suite of models, including new models and updates released during 2019, as well as updated industry exposure databases (IEDs). The paper includes AIR's presentation of global EP metrics on both an insured and insurable basis, where insurable loss metrics include all exposures eligible for insurance coverage assuming standard limits and deductibles, regardless of whether they are actually insured.[3] For regions and perils covered by catastrophe models, this difference presents not only potential

[3] Insurable loss metrics for Japan were calculated using 100% limits for typhoon and earthquake.

business growth opportunities for the insurance industry to offer essential protection to vulnerable home- and business-owners, but a responsibility to act.

Such a difference was especially evident when Hurricane Harvey struck Texas in 2017 and Hurricane Florence struck the Carolinas in 2018, for example. While the United States has good insurance penetration generally, the damage caused by Harvey's and Florence's flooding was largely uninsured. While the "Midwest floods" in the first half of 2019 and Hurricane Barry have not caused floods as significant as Harvey and Florence from a loss perspective, they remind us not to be complacent about the U.S. inland flood insurance gap. After experiencing two strong earthquakes in California this year, the large difference between insured and insurable earthquake-related losses in the U.S. looms large—especially in California where, if the "Big One" were to occur, nearly 75% of the losses would be uninsured.[4] Thus the difference between insured and insurable losses is a problem not limited to developing countries. Finding ways to address this gap remains one of the primary challenges facing the insurance industry.

Also discussed in the 2019 update are global economic losses from catastrophes, which can vastly exceed insured losses depending on the region and peril. This "protection gap"—the difference between economic and insured losses—highlights the significant burden that society faces when a disaster strikes. The cyclones in Mozambique illustrate the difference between a storm with the intensity of a major hurricane making landfall in a country with less than 2% insurance penetration, despite 22.7% growth in 2017[5], and one that makes landfall in a well-developed insurance market such as when Typhoon Jebi struck Japan. For the insurance industry, the protection gap can spur innovation in product development. In the public sector, governments are recognizing the importance of moving from reactive to proactive risk management, especially in countries where a risk transfer system is not well established. Understanding the protection gap can help governments assess the risks to their citizens and critical infrastructure, and develop risk-informed emergency management, hazard mitigation, and public risk financing strategies to enhance global resilience and reduce the ultimate costs.

---

[4] The "Big One" alluded to is an M7.9 earthquake similar to the 2008 ShakeOut scenario that ruptures 73 segments of the San Andreas fault.

[5] Lusa – Portuguese News Agency

AIR is uniquely qualified to provide the global (re)insurance industry, financial institutions, governments, and non-governmental organizations with the insightful view of risk presented in this paper for the following reasons:

- AIR develops and maintains a detailed IED—including counts, replacement values, and physical attributes of insurable properties—for each modeled country.[6] These IEDs serve as the foundation for all modeled industry insured and insurable loss estimates and make the generation of a global industry EP curve a straightforward task.[7]
- AIR's year-based simulation approach enables model users to determine the probability of various levels of loss for years with multiple catastrophic events, across multiple perils and multiple regions.
- AIR models the risk from natural catastrophes and other perils (including pandemic, terrorism, cyber, and casualty) in more than 110 countries, affording AIR a truly global perspective.[8]

Industry insured losses can and do occur as a result of perils and in regions for which AIR does not yet provide models; these losses are not included in AIR's global estimates. AIR, however, is committed to continually expanding model coverage and is engaged in an aggressive model development program.

[6] AIR has developed and maintains IEDs for all modeled countries with the following exceptions: Brazil, Brunei, Malaysia, and Thailand.

[7] For countries with IEDs that were not updated in 2019, index factors were applied to calculate the global aggregate average annual loss (AAL) and exceedance probability (EP) loss metrics for both insured and insurable losses in this report. The U.S. and China also received indexed updates to their IEDs by county and province, respectively, and by line of business.

[8] The modeled losses in this paper cover property and crop risk. Because of the unique catalog architecture of the AIR pandemic, cyber, and casualty models, modeled losses for these perils were excluded from the analyses in this paper; the new India MPCI model was released after the writing of this paper, so modeled loses for this peril are also excluded.

Industry Exposure Databases Give AIR Unique Global Risk Insight

AIR builds its industry exposure databases (IEDs) from the bottom up, compiling detailed data about risk counts, structure attributes (parameters that greatly influence the ability to withstand high winds, ground motion, and flood depth), and replacement values, as well as information on standard policy terms and conditions. AIR then validates key attributes of the database through a top-down approach, using aggregate data from multiple additional sources. Coupling these approaches results in aggregated industrywide IEDs that are both objective and robust.

High-resolution IEDs for modeled countries—and a straightforward and intuitive catalog-generation process—enable AIR to provide insight into the likelihood of different levels of loss on a global scale. In some regions, lack of current data, data access, and poor data quality can pose challenges to IED development and maintenance. In such cases, index factors are created using demographic data from additional sources and employed to project the data forward.

Learn more about the development, maintenance, advantages, and critical role of IEDs in reliable catastrophe modeling in "Modeling Fundamentals: AIR Industry Exposure Databases."

Exceedance Probability Metrics

Insured and Insurable Losses

The global aggregate average annual loss (AAL) and exceedance probability loss metrics for 2019) reflect changes in risk as a result of updated models (New Zealand earthquake, European extratropical cyclone (Great Britain storm surge only), Central European flood, and China typhoon); they also comprise the update to AIR's industry exposure database for New Zealand.

Global insured AAL and key metrics from the aggregate exceedance probability (EP) curve from 2012–2019 are presented in Table 1.

Table 1. Key insured loss metrics from AIR's global industry EP curve for all regions and perils. (Source: AIR)

Year	AAL (USD Billions)	Aggregate EP Loss (USD Billions)	
		1.0% (100-year return period)	0.4% (250-year return period)
2012	59.3	205.9	265.1
2013	67.4	219.4	289.1
2014	72.6	231.5	292.5
2015	74.4	232.8	304.8
2016	80.0	252.9	325.3
2017	78.7 **(Insurable: 167.2)**	246.9 **(Insurable: 602.7)**	325.3 **(Insurable: 952.3)**
2018	85.7 **(Insurable: 181.8)**	270.9 **(Insurable: 654.2)**	341.9 **(Insurable: 1,057.9)**
2019	91.8 **(Insurable: 191.4)**	288.2 **(Insurable: 655.2)**	366.2 **(Insurable: 1,004.4)**

Average annual insured losses and the metrics from the aggregate insured EP curve—for all regions and perils modeled by AIR—have generally increased since the first white paper was published in 2012. This is expected; the rise reflects both increases in the numbers and values of insured properties in areas of high hazard and the inclusion of regions and perils for which new models are now available. This year, for the first time we observed a decrease in two regions that was largely unrelated to hazard changes within the models: economic crises in both Turkey in the European region and Venezuela in the Latin America region resulted in significant devaluation of their currencies relative to the U.S. dollar, leading to decreases in overall losses.

The insurable loss metrics include all exposures eligible for insurance coverage, regardless of whether they are actually insured. They represent the total damage minus deductibles and limits.[9] On a global basis, modeled insurable AAL is more than twice as high as the insured AAL, as are global insurable losses at the 1.0% exceedance probability. Looking even further down the EP curve, global insurable losses at the 0.4% exceedance probability are almost three times the insured.

[9] In cases where index factors were applied to derive insured loss metrics, those same index factors were applied to obtain comparable insurable loss metrics, which can result in take-up rates that exceed 100%.

A breakdown of contribution to global AAL by region and key aggregate EP metrics by region appears in Table 2. The difference between insured and insurable loss is most pronounced in Asia, where insurance penetration remains very low.

Table 2. AAL and EP metrics, by region, based on AIR's global suite of models, including those introduced or updated in 2018. (Source: AIR)

Region	AAL (USD Billion)		Aggregate EP Loss (USD Billion)			
	Insured	Insurable	1.0% (100-year return period)		0.4% (250-year return period)	
			Insured	Insurable	Insured	Insurable
Asia	12.0	50.9	69.8	455.7	95.2	878.9
Europe	14.0	22.0	58.1	110.7	77.7	146.3
Latin America (the Caribbean, Central America, South America)	5.2	9.7	42.6	77.4	58.2	104.4
North America (Canada, the United States, Bermuda, Mexico)	57.4	105.3	237.9	354.0	316.7	454.5
Oceania	3.2	3.6	21.7	23.9	39.4	43.9
All exposed areas*	**91.8**	**191.4**	**288.2**	**655.2**	**366.2**	**1,004.4**

*Note that aggregate EP losses are not additive, as noted in the box "Understanding the Exceedance Probability Curve."

Figure 1 shows the contribution to global insured AAL by peril.

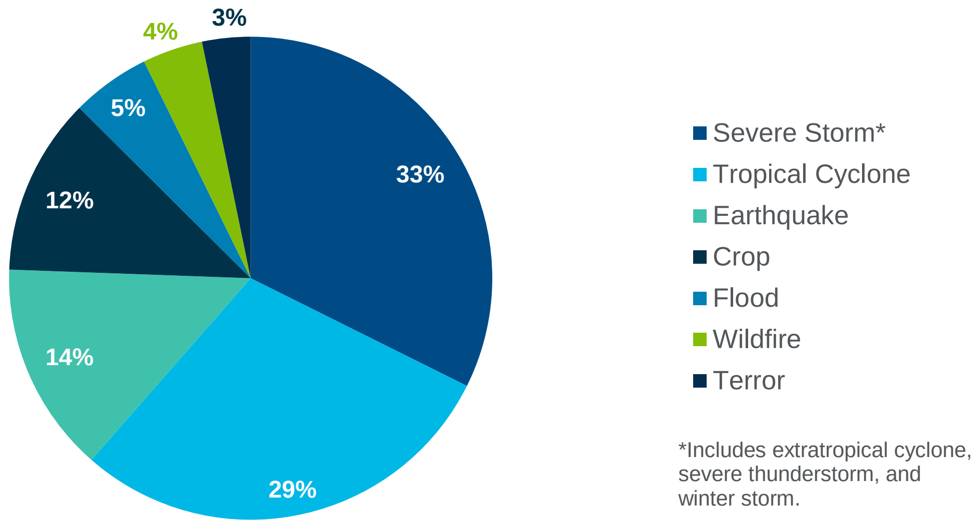

Figure 1. Contribution to global insured AAL by peril for all regions. (Source: AIR)

Figure 2 shows the contribution to global insurable AAL by peril.

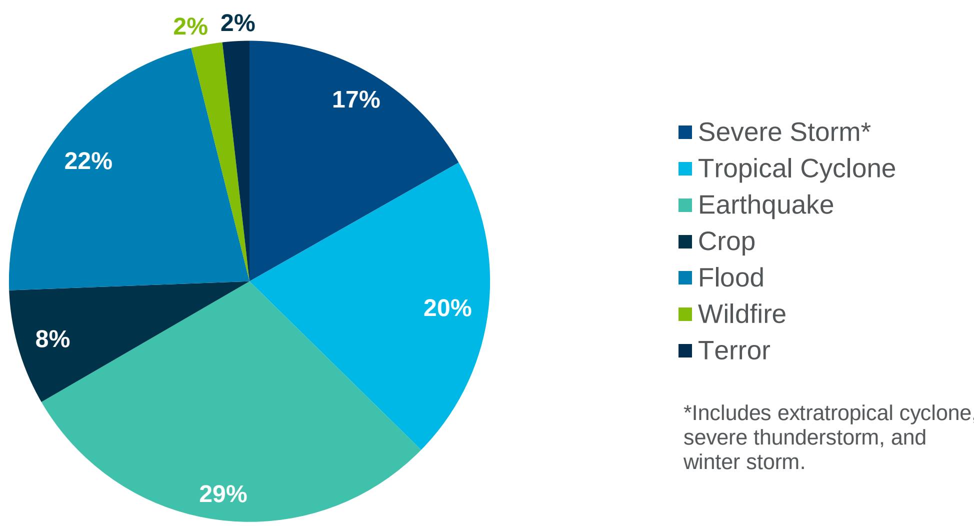

Figure 2. Contribution to global insurable AAL by peril for all regions. (Source: AIR)

It is important to note that AAL represents average expected losses over a long period of time, not what would be expected in any given year. As reflected in AIR's stochastic catalogs, global aggregate losses in any given year may comprise a few large loss events in peak regions or lower losses from multiple perils across multiple regions; what is certain is that they are unlikely to look like the long-term AAL breakdowns shown in Figure 1 and Figure 2.

Understanding the Exceedance Probability Curve

To meet the diverse needs of model users, AIR's catastrophe models provide a wide range of modeled loss output. One of the most commonly used outputs is a distribution of potential losses with the associated probabilities of exceedance. These exceedance probability (EP) curves—which can be specific to peril, region, or line of business—quantify the risk profile for whole portfolios or individual risks and can be used to inform a variety of risk management decisions.

Understanding how AIR develops its stochastic catalogs of simulated events helps one understand how the EP curves are generated. To create a stochastic catalog for a given peril, scientists first gather information on historical events from a comprehensive range of sources. This data is then used to infer what can happen in the future; that is, to indicate where and how frequently certain types of events are likely to occur and how large or severe the events are likely to be. A 10,000-year hurricane catalog, for example, contains 10,000 potential scenarios for tropical cyclone activity in an upcoming year. Importantly, although the simulated events have their basis in historical data, they extend beyond the scope of past recorded experience to provide the full spectrum of future potential catastrophe events.

To generate the EP curves, first an AIR catalog is run against the portfolio of exposures. Next, the loss for each event in each modeled year is calculated. (Some modeled years will have multiple events, some a single event, and some no events.) Then modeled years are ranked from highest loss to lowest loss, based on loss figures calculated for either *occurrence* loss (based on the largest event loss within each modeled year) or *aggregate* loss (based on the sum of all event losses of each modeled year).

Finally, EPs corresponding to each loss—occurrence or aggregate—are calculated by dividing the rank of the loss year by the number of years in the catalog. Thus, for a 10,000-year catalog, the top-ranked (highest loss) event would have an EP of 0.0001 (1/10,000) or 0.01%, the 40^{th}-ranked event an EP of 0.004 (40/10,000) or 0.40%, the 100^{th}-ranked event an EP of 0.01 (100/10,000) or 1.00%. The return period for a loss level equals the inverse of EP: EPs of 0.01%, 0.40%, and 1.00%, for example, correspond to 10,000-, 250-, and 100-year return periods.

Model users should keep in mind that EP metrics provide the probability of a certain *size* loss, not the probability that a specific *event* or *events* will occur. Also, the probability of an event or events occurring exactly as modeled (or the exact recurrence of a historical event) is virtually zero, although a wide range of event scenarios may cause a similar level of loss.

Average annual losses (AALs) for exposed areas—such as the regions listed in Table 2—can be summed because the region figures were calculated by averaging losses across all modeled years. Aggregate EP losses are not additive and thus—again referring to Table 2—do not equal the sums of the regional aggregated EPs.

To read more about how exceedance probability curves are constructed and how they should be interpreted, see the articles "Modeling Fundamentals: What Is AAL?" and "Modeling Fundamentals: Combining Loss Metrics."

Economic Losses

Global economic losses include insured and insurable losses, as well as losses from non-insurable sources, which may include infrastructure and lost economic productivity. Comparing insured losses with reported economic loss estimates for natural disasters since 1990 (as reported by Swiss Re, Munich Re, Aon Benfield, AXCO, Lloyd's, and the Insurance Bureau of Canada), AIR has determined that global insured losses make up about a quarter of global economic losses on average, when trended to 2018 dollars. Based on AIR's modeled global insured AAL, this would correspond to an economic AAL of more than USD 393 billion.

On a regional basis, the percentage of economic loss from natural disasters that is insured varies considerably (Table 3). In North America, for example, about 40% of the economic loss from natural disasters is insured, while in Asia and Latin America, insured losses account for only about 9% and 14% of economic losses, respectively, reflecting the very low insurance penetration in these regions. The portion of economic losses that is insured also varies significantly by peril. For example, in the United States, windstorm coverage is near universal, while take-up for flood and earthquake is low, as these perils are typically excluded from standard homeowner's policies. In other countries, such as the UK, coverage for natural catastrophes (including storm, flood and earthquake) is nearly universally provided by the insurance sector, and the disparity between the perils in the portion of economic losses that is insured is much less pronounced.

Table 3. Insured and economic AAL by region* (Source: AIR)

Region	Insured AAL (USD Billion)	Percentage of Economic Losses Estimated to Be Insured	Economic AAL (USD Billion)
Asia	12.0	9%	133.3
Europe	14.0	22%	63.6
Latin America (the Caribbean, Central America, South America)	5.2	14%	37.1
North America (Canada, the United States, Bermuda, Mexico)	57.4	38%	151.1
Oceania	3.2	37%	8.6
All exposed areas	**91.8**	**24%**	**393.8 (sum of regional losses)**

*Note that there is considerable uncertainty in the estimated percentage of economic losses that is insured, which partly stems from uncertainty in reported economic losses for actual catastrophes.

The sizable difference between insured and economic losses—the protection gap—represents the cost of catastrophes to society, much of which is ultimately borne by governments. Increasing insurance penetration can ease much of the burden, while providing profitable growth opportunities for the insurance industry. In situations where insurance is not feasible or cannot be offered at an affordable price, catastrophe modeling can be used to inform emergency management, hazard mitigation, public disaster financing, risk pooling, and other government-led risk and loss mitigation initiatives to enhance global resilience.

Using the same techniques that were used to quantify the protection gap on an AAL basis, the insured and economic losses for each region at the 1% exceedance probability (the 100-year return period) can be calculated. The difference between economic and insured losses—the uninsured losses—includes all of the potential losses covered in the insurable loss figures from AIR's models that were cited in Table 2 and, in addition, losses that extend beyond the models' scope, including estimates of damage to roads, bridges, railways, and sewers, as well as the global electrical and telecommunications networks and other infrastructure (Figure 3). Looking at this metric reinforces the need for additional risk financing solutions.

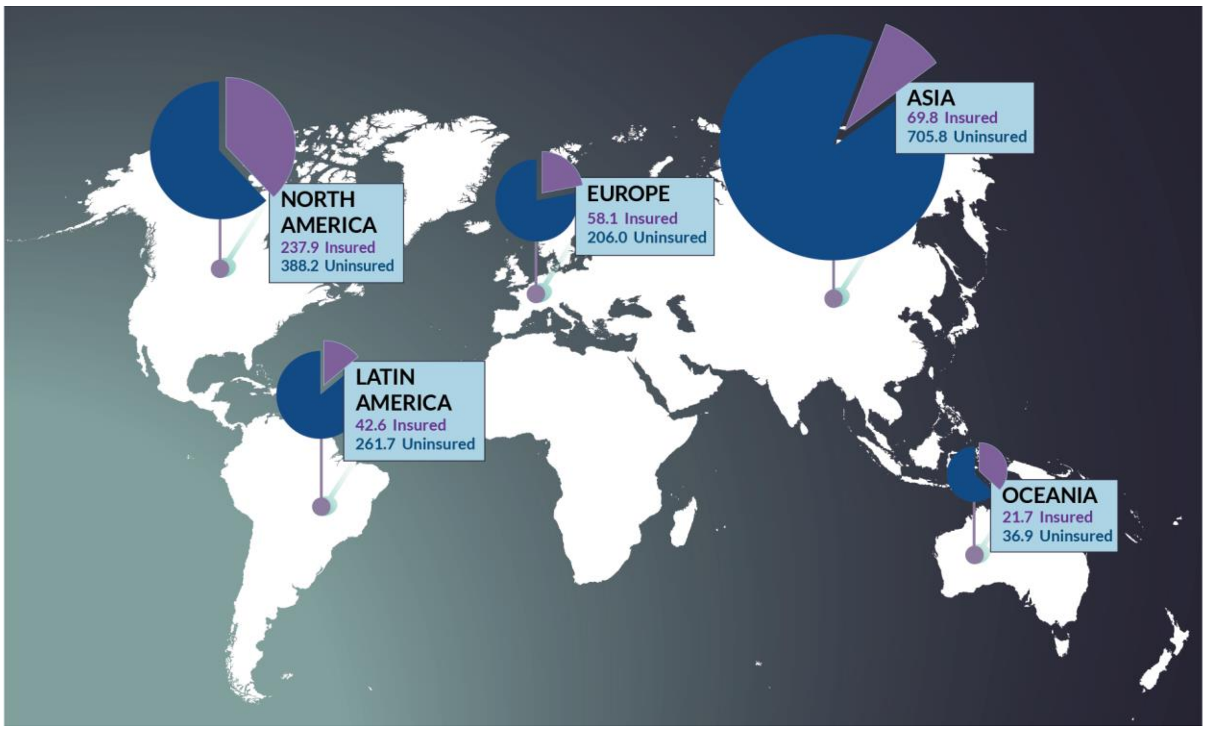

Figure 3. The gap between insured and total economic losses (the sum of insured and uninsured losses), by region, at the 1% exceedance probability (100-year return period) level. (Source: AIR)

To help close the protection gap, AIR launched a Global Resilience Practice in 2016 that provides risk assessment and mitigation solutions to governments and non-governmental organizations. AIR is actively supporting many such initiatives through work with organizations such as the World Bank and the Insurance Development Forum, and its support of efforts such as OpenQuake—an open source modeling platform initiative led by the Global Earthquake Model. And as government organizations become more familiar with probabilistic catastrophe models, they are beginning to embrace them, as the Federal Emergency Management Agency did in 2017 when it licensed AIR's Inland Flood Model for the U.S.

Non-Modeled Sources of Insured Loss

Industry insured losses can and do occur from perils and in regions that AIR does not currently model. Those losses are therefore not included in AIR's global insured estimates. (See "AIR Models by Peril and Region" for a comprehensive listing of AIR's model coverage.) If all losses could be modeled and included in AIR's calculations, the aggregate insured loss figures at given EPs would be slightly higher; likewise, the EPs associated with given loss figures would be slightly higher.

AIR's current suite of models—which covers perils in more than 110 countries—captures catastrophe events responsible for 94% of worldwide insured losses for the 19-year period from 2000 through 2018, as shown in Figure 4.

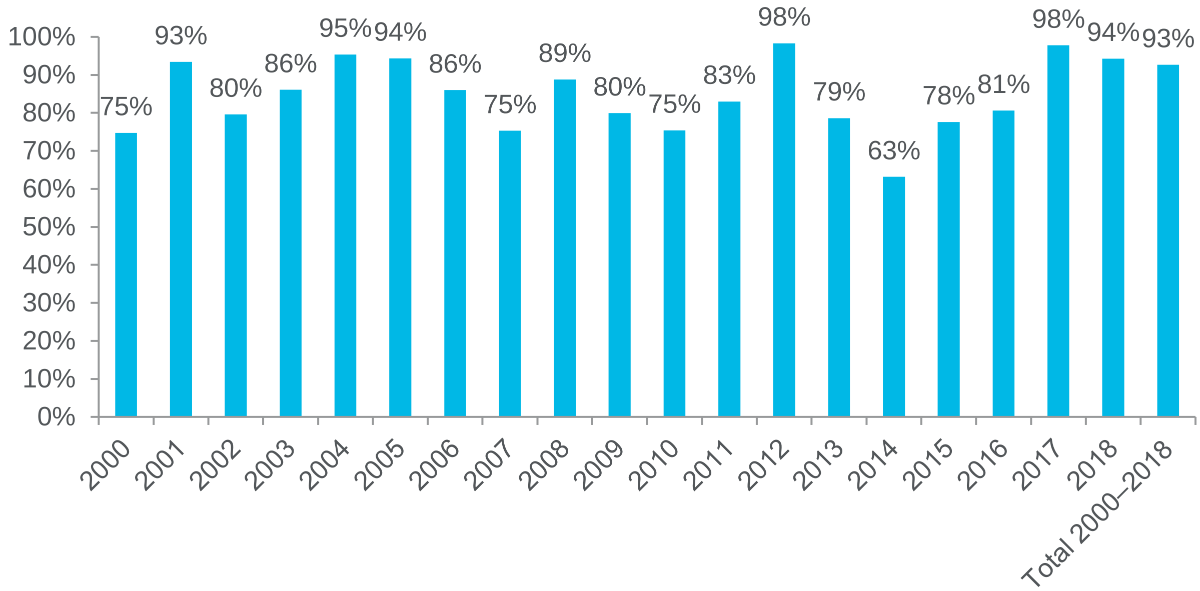

Figure 4. The percentage of reported insured losses covered by AIR's current suite of models, 2000–2016. (Source: AIR, Swiss Re, AXCO, Munich Re, PCS, Aon Benfield, PERILS)

As indicated in Figure 4, AIR models covered 94% of the global reported insured losses for 2018. Floods and severe thunderstorms in China accounted for the majority of non-modeled losses, while severe thunderstorms in India and floods in Australia also contributed. The accumulation of these events, in addition to smaller non-modeled events that occurred in 2018, contributes greatly to worldwide annual non-modeled sources of loss.

To better serve the needs of the industry, AIR continues to expand into previously non-modeled regions and perils through an ambitious model development program and research roadmap. Recently released models not considered in this paper include the India MPCI model and the industry's first probabilistic cyber model; models on the roadmap include updated U.S. flood and hurricane models, as well as hurricane and earthquake models for the Caribbean, and a major update to the Australia earthquake model. Expansion into new frontiers of risk is also under way:

- With the addition of Arium probabilistic casualty models, the domino effect of liability risk can be modeled across all types of businesses to assess potential losses that can be slow to accumulate and impact multiple industries in today's interconnected global economy
- Climate change remains an active area of research, and all AIR models reflect the current climate to better represent today's risk
- AIR offers advanced solutions on a consulting basis for managing accumulations associated with supply chain
- Terrorism risk can be assessed and managed worldwide through the deterministic modeling capabilities offered through the AIR model
- AIR is developing a life and health platform to streamline the assessment and management of this dynamic risk, which evolves as global connectivity grows, animal habitats alter, medical advancements continue, the population ages, and the climate changes

AIR also provides modeling tools that can help companies understand the risk from non-modeled sources of loss. Companies can deploy their own or third-party models on Touchstone using AIR's Model Builder™, which helps them define their own hazard and engineering components before deploying them in Touchstone's open platform. In addition, Touchstone and Touchstone Re users have the flexibility to modify modeled losses by line of business, region, or peril to account for non-modeled sources of losses.

Touchstone loss curves (Year Event Loss Tables, or YELTs) can be exported directly into Analyze Re—our lightning-fast analytics platform—to assess loss data from reinsurance contracts and portfolios in real time. Analyze Re technology is designed to help executive teams and underwriters explore long-term, strategic planning and portfolio optimization scenarios without sacrificing control. We are also integrating Analyze Re technology into Touchstone Re to facilitate portfolio rollups, pricing of individual contracts and optimizing portfolios downstream of catastrophe model analytics.

Conclusion: The Importance of a Global View

Since catastrophe risk can threaten a company's financial well-being, companies operating on a world stage need to understand their risk *across* global exposures to ensure they have sufficient capital to survive years of very high loss. Understanding—and *owning*—this risk requires knowing both the likelihood of high-loss years and the diversity of events that could produce such losses. In addition, companies with global exposures and an expanding global reach should prepare for the possibility that future catastrophes will produce losses exceeding any historical amounts.

Companies that evaluate loss on a global scale, rather than regionally or even nationally, should always look at more than one peril (or one region) to assess the risk at a given exceedance probability (EP). If a company considered only its worst single peril, it could severely understate risk at a given EP because for a given modeled year losses from a combination of other events (different perils in different regions) likely would equal or exceed the worst single peril. As discussed in the "Understanding the Exceedance Probability Curve" box, EP curves can be developed for both occurrence (based on the largest loss event in each catalog year) and aggregate (based on the sum of all loss events in each catalog year). Aggregate EP is a far better measure of portfolio risk.

By providing both global insured and insurable loss estimates based on the EP curve, the need to better understand the risk becomes evident; the difference between covered and eligible exposures suggests areas of potential profitable growth in markets already identified as vulnerable to catastrophic events. Examination of economic and insured losses reveals how wide the protection gap is and how sizable losses are for societies after a catastrophe, which can inform risk mitigation, public risk financing, and emergency management to enhance global resilience and better prepare society for the ultimate costs.

With the insight provided by AIR's global suite of models, companies can pursue profitable expansion in a market that is ever more connected, and amid regulatory environments that are increasingly rigorous. The ability to take a comprehensive, global view can give insurers and reinsurers greater confidence that the risk they have assumed is risk they can afford to take. The global EP curves generated with AIR software give companies the knowledge with which to benchmark and manage catastrophe risk in more than 110 countries worldwide.

About AIR Worldwide

AIR Worldwide (AIR) provides risk modeling solutions that make individuals, businesses, and society more resilient to extreme events. In 1987, AIR Worldwide founded the catastrophe modeling industry and today models the risk from natural catastrophes, terrorism, pandemics, casualty catastrophes, and cyber incidents. Insurance, reinsurance, financial, corporate, and government clients rely on AIR's advanced science, software, and consulting services for catastrophe risk management, insurance-linked securities, longevity modeling, site-specific engineering analyses, and agricultural risk management. AIR Worldwide, a Verisk (Nasdaq:VRSK) business, is headquartered in Boston, with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.

AIR

A Verisk Business