Global Modeled Catastrophe Losses

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AIR
A Verisk Business

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Table of Contents

Introduction **3**
Industry Exposure Databases Give AIR Unique Global Risk Insight 9

Exceedance Probability Metrics **10**
Insured and Insurable Losses.. 10
Understanding the Exceedance Probability Curve.................................. 14
Economic Losses.. 15

Non-Modeled Sources of Insured Loss.. **17**

Conclusion: The Importance of a Global View **19**

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]

On December 31, 2019, 44 cases of pneumonia from an unknown cause were reported in China. By January 12 the disease agent was determined to be a previously unidentified coronavirus, and its genetic sequence was shared with researchers globally. The first imported case, in Thailand, was identified the next day and has since spread to the rest of the world, causing what we commonly refer to as the COVID-19 pandemic. The pandemic continues as of this writing, having caused more than 1.2 million deaths globally; roughly half of those deaths were reported in the United States, Brazil, India, and Mexico. The pandemic affected emergency preparation measures for various 2020 events.

The year 2020 opened with the most powerful earthquake Puerto Rico had experienced since 1918—the last time the island updated its earthquake preparedness plan. Still reeling from the effects of Hurricane Maria (2017), Puerto Rico was struck by an Mw 6.4 earthquake just 8 km off the southern coast, near Indios, on January 7. The temblor came after a series of more than 500 smaller earthquakes in the preceding weeks as well as an Mw 5.8 quake one day earlier. Also in January numerous bushfires continued to burn across Australia. Since the second half of 2019, the fires had scorched more than 10 million hectares (~25 million acres) and destroyed more than 2,600 homes, mainly in Australia Capital Territory, New South Wales, Queensland, South Australia, Tasmania, and Victoria. Later in the month, an M6.7 earthquake struck 4 km east-northeast of Doganyol, and 40.1 km north-northeast of Elazig, Turkey. While the impacts were serious, they were not as serious as some historical earthquakes that have struck Turkey, such as the Van and Izmit quakes in 2011 and 1999, respectively.

The month of February brought one notable European winter storm, Ciara-Sabine. Ciara struck parts of Ireland and the UK on the 9th, then moved to Europe where it was named Sabine in Germany and also impacted France, the Netherlands, Belgium, Poland, the Czech Republic, Slovenia, Sweden, Denmark, and Norway (where it was called Elsa), and other European countries.

[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," "2018 Global Modeled Catastrophe Losses," and "2019 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; catastrophes in 2019 include Typhoon Faxai and Typhoon Hagibis in Japan.

On March 2 in the United States, an early season severe weather outbreak spawned several tornadoes that affected five southeastern states, including an EF-3 tornado that impacted the City of Nashville, Tennessee, and environs very early the next morning, killing 25 people and damaging more than 100 homes and businesses. On March 18, an M5.7 earthquake struck 15 km west of Salt Lake City—the largest earthquake in Utah since 1992. Although the highest earthquake hazard in the continental United States is largely associated with California and drops significantly across the Rocky Mountains in the Central and Eastern United States, the hazard does not disappear. The entire western half of the United States is full of seismic sources. The impact of the pandemic during a cat event was experienced for the first time in the U.S. on a large scale, as most people were at home when the quake struck to prevent the spread of the pandemic; emergency responders asked if callers were experiencing symptoms so that they could don protective gear before responding; and virus testing was delayed and the coronavirus hotline shut down temporarily during damage assessments.

The first typhoon of the year, Vongfong (Ambo), made landfall on May 14 with the equivalent intensity of a Category 3 hurricane on the Saffir-Simpson Scale, in Eastern Samar Province, Philippines, about 350 miles southeast of Manila. Vongfong weakened as it moved across the Eastern Visayas region, and many homes in Eastern Samar and Northern Samar provinces, as well as Luzon, were either destroyed or severely damaged. More than 145,000 people were reported to have been evacuated; sheltering efforts in the affected areas were hampered by requirements for social distancing during the COVID-19 pandemic. Less than a week later, Cyclone Amphan made landfall with an intensity equivalent to a Category 2 hurricane near Digha, West Bengal, India, and Hatiya Island in Bangladesh. The storm brought heavy rains and high winds to many districts in Bengal, and to the capital city of Kolkata, as well as to districts in Odisha. The path of Amphan was close to that of Cyclone Bhola in 1970, which caused severe flooding in the Gangetic plains and delta. Although India is much better prepared today than it was in 1970 for a strong storm, the COVID-19 pandemic complicated evacuation efforts.

The U.S. hurricane season got off to an early start with tropical storms Arthur and Bertha forming before the official start of the season on June 1. This would be a common theme throughout the 2020 season with most named storms making their earliest appearance for their letter.

One of the costliest natural disasters ever in Canada struck on June 13: the Calgary hailstorm. Hailstones the size of tennis balls damaged at least 70,000 homes and vehicles mainly across northeast Calgary, Airdrie, and Rocky View counties. June also brought an M7.4 earthquake that struck a sparsely populated area of the west coast in the state of Oaxaca, Mexico, on the 23rd. Damage included the collapse of buildings and façades. Buildings swayed in Mexico City, about 650 km away from the epicenter, where a widespread power outage was also experienced. Ten deaths and 24 injuries were reported. Although this quake was strong, it didn't cause nearly the insured losses of two that struck Mexico in September 2017—the M8.1 Chiapas and the M7.1 Puebla two weeks later.

The traditional peak of the wildfire season across the U.S. Southwest occurs in June and early July; by late June the Bush Fire in Arizona had become the largest wildfire active in the country and one of the largest recorded in the state. This trend would continue in the Western U.S.

The month of July saw tropical storms Edouard, Fay, and Gonzalo all break records for earliest fifth, sixth, and seventh named storms, respectively. Hurricane Hanna made two landfalls in Texas at the end of July, bringing high winds and heavy rains—12 inches in some areas—to southern Texas near the border of Mexico as it dissipated over land. At the end of July, Hurricane Isaias passed the Bahamas on its way to the U.S. East Coast. In early August the storm traveled along the coasts of Florida, Georgia, and South Carolina, where winds of up to 40 mph and heavy rains were experienced, before making landfall in Ocean Isle Beach, North Carolina, as a Category 1 storm late on August 3. Isaias was notable for its inland impacts, as it brought tropical storm–force winds, hurricane-force gusts, and heavy rains to Virginia, Washington, D.C., Maryland, Delaware, and Pennsylvania, New Jersey, New York and New England states on August 4, causing millions to lose power.

On August 9, an M 5.1 earthquake struck near Sparta, North Carolina, close to the Virginia border, the strongest in the state in nearly 100 years. On August 10, a derecho caused widespread catastrophic damage in the Midwest, bringing heavy rainfall and hurricane-force winds as well as significant hail in some locations. The storm system that produced it formed early in the day in the eastern end of the South Dakota-northeastern Nebraska border area and intensified rapidly as it moved eastward across Iowa at an average forward speed of 55 mph sustaining extreme winds. Continuing through Illinois, Wisconsin, and northern Indiana winds moderated only slightly, and 17 confirmed tornadoes formed. The system continued through Michigan and western Ohio in the evening, weakening and finally dissipating as it did so, having traveled a total of about 1,000 miles. In late August, the Pine Gulch Fire became the largest in Colorado's recorded history. And starting with the last week of August, three typhoons in as many weeks impacted South Korea: Bavi, Maysak, and Haishen.

Late August also saw the first of four hurricanes to hit the Gulf Coast. On August 27, Category 4 Hurricane Laura made landfall in Louisiana, near the Texas border; on September 16, Category 2 Hurricane Sally made landfall in Alabama, near the Florida border; on October 9, Category 2 Hurricane Delta made landfall near Creole, Louisiana, roughly 6 weeks after and 12 miles away from Laura's landfall; and on October 28 high-end Category 2 Hurricane Zeta made landfall near Cocodrie, Louisiana. Considering all four of these hurricanes—Laura, Sally, Delta, and Zeta—the entire coastline from eastern Texas near the Louisiana border to the western Florida Panhandle was impacted by hurricanes in 2020. Zeta was the 27th named storm of the season—tying the record for number of named storms in the Atlantic, set in 2005—and the 11th to make landfall in the

United States, breaking the previous record for the number of U.S.- landfalling named storms set in 1916.

By October 4, California's wildfires had burned 4 million acres, twice the acreage ever burned by wildfire in one year's time, with nearly 3 months left of the year. In addition, the August Complex Fire became the largest wildfire in the state's recorded history, the first-ever recorded "gigafire," so called because it burned more than 1 million acres. The previous recordholder for largest California wildfire was the Mendocino Fire, which burned only two years ago and less than half the acreage. The Mendocino Fire burned double the acreage than the previous recordholding fire, which had burned just the year before. Five of the six largest wildfires ever to burn in California's recorded history occurred in 2020. In October, Colorado's Mullen Fire (176,000+ acres at 97% contained) surpassed the Pine Gulch Fire (139,000 acres before containment) to become the largest ever in that state in less than two months. In early November, the Cameron Peak (208,000+ acres) and East Troublesome (193,000+ acres) fires, only 10 miles apart from each other, became the two largest fires ever in Coloado's recorded history. In Washington State, the Cold Springs Canyon/Pearl Hill Fire is the largest in recorded history in that state, 25% larger than the second-largest.

On October 28, Typhoon Molave made landfall with 1-minute sustained wind speeds of 149 km/h, the equivalent of a high-end Category 1 hurricane, in Quang Nam Province, Vietnam. Molave was one of the strongest typhoons to hit central Vietnam in decades and the fourth named storm to hit the country in October. On October 30, the magnitude 7.0 Néon Karlovásion earthquake struck below the Aegean Sea about 13.5 km (8.5 miles) off the northern coast of the Greek island of Samos, located just south off the coast of western Turkey. The temblor caused buildings to collapse in both Turkey and Greece, strongly impacting Turkey's third largest city, Izmir. Tremors were felt across the region as far away as Istanbul and the Greek capital, Athens. The quake also generated a small tsunami, which struck several island towns, including on Samos, as well as coastal Turkey mostly near Izmir.

On November 1, local time, Typhoon Goni made a first landfall on Catanduanes Island, the Philippines, with 1-minute sustained wind speeds of 256 km/h and a minimum central pressure of 905 mb, the equivalent of a Category 5 hurricane. Goni made a second landfall on the main island of Luzon in Quezon, later that day with 1-minute sustained wind speeds of 181 km/h and a minimum central pressure of 965 mb, the equivalent of a low-end Category 3 hurricane. Goni was the strongest typhoon this year and is one of the strongest to hit the Philippines since Haiyan in 2013. It weakened rapidly once it encountered land, however, and did not incur significant insured losses. On November 4, Category 4 Hurricane Eta brought heavy rainfall and strong winds to Nicaragua and Honduras and other parts of Central America.

Throughout 2020, many countries have experienced severe flooding at least once this year. Notable flooding events have impacted China; the state of Kerala, India, although not as severely as in 2018; South Korea; and Japan; and many other countries in Asia, Africa, Europe, and the Americas.

Preparing for large losses *before* they occur is critical to continued solvency and resilience.

The 2020 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 2020, 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 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 Hurricane Sally did not cause floods as significant as Harvey and Florence from a loss perspective, this storm reminds us not to be complacent about the U.S. inland flood insurance gap. After earthquakes stronger than M5.0 struck both Utah and North Carolina and an M7.4 struck Mexico, 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 2020 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. Typhoons Vongfong and Goni, which struck the Philippines; Cyclone Amphan, which struck India and Bangladesh; and Hurricane Eta, which struck Nicaragua and impacted other countries in Central America illustrate the difference between a storm with the intensity of a hurricane making landfall in a country with low insurance penetration and one that makes landfall in a well-developed insurance market such as when Typhoon Hagibis struck Japan last year. 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

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

[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.

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.

While pandemics are not included in the global property EP metrics, AIR has been closely monitoring the COVID-19 pandemic since December of last year. We shared a hypothetical study of the coronavirus' spread in early March and have provided publicly available case and fatality estimates for the COVID-19 crisis since early April through the Verisk COVID-19 Projection Tool. We also discussed the potential impacts to supply chain risk and casualty risk as well as the influence of climate on pandemics.

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.[5] 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.[6]
- 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.[7]

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.

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

[6] 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.

[7] 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.

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 2020) reflect changes in risk as a result of updated models (Australia earthquake, Caribbean earthquake, Caribbean tropical cyclone, China MPCI, U.S. inland flood, and U.S. hurricane); they also comprise the update to AIR's industry exposure databases for all 29 Caribbean countries/territories modeled and reflect the addition of precipitation-induced flooding to the U.S. hurricanes and the inclusion of detailed insurance take-up rates for flood in the U.S.

Global insured AAL and key metrics from the aggregate exceedance probability (EP) curve from 2012–2020 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)

		Aggregate EP Loss (USD Billions)	
Year	**AAL (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)**
2020	99.6 **(Insurable: 204.0)**	301.1 **(Insurable: 701.1)**	376.3 **(Insurable: 1,095.2)**

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. Changes in the hazard component of one model resulted in significant reductions in the insured and insurable losses for AIR's Australia earthquake model, impacting losses in the Oceania region.

This year, we continued to see a decrease in two regions that was largely unrelated to hazard changes within the models: significant inflation in both Turkey in the European region and Venezuela and Argentina in the Latin America region resulted in significant devaluation of their currencies relative to the U.S. dollar, leading to some decreases in insurable losses. For Latin America, this change was offset by the updates to the Caribbean Industry Exposure Databases.

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.[8] 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.

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 2020. (Source: AIR)

	AAL (USD Billion)		Aggregate EP Loss (USD Billion)			
			1.0% (100-year return period)		0.4% (250-year return period)	
Region	Insured	Insurable	Insured	Insurable	Insured	Insurable
Asia	15.9	69.7	76.4	497.4	102.3	954.2
Europe	14.1	21.8	58.9	108.8	77.6	137.6
Latin America (the Caribbean, Central America, South America)	5.2	12.3	44.9	105.6	59.7	142.8
North America (Canada, the United States, Bermuda, Mexico)	61.9	94.6	250.5	361.0	330.5	482.6
Oceania	2.6	2.9	17.0	18.9	25.6	27.4
All exposed areas*	**99.6**	**204.0**	**301.1**	**701.1**	**376.3**	**1,095.2**

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

[8] 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%.

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

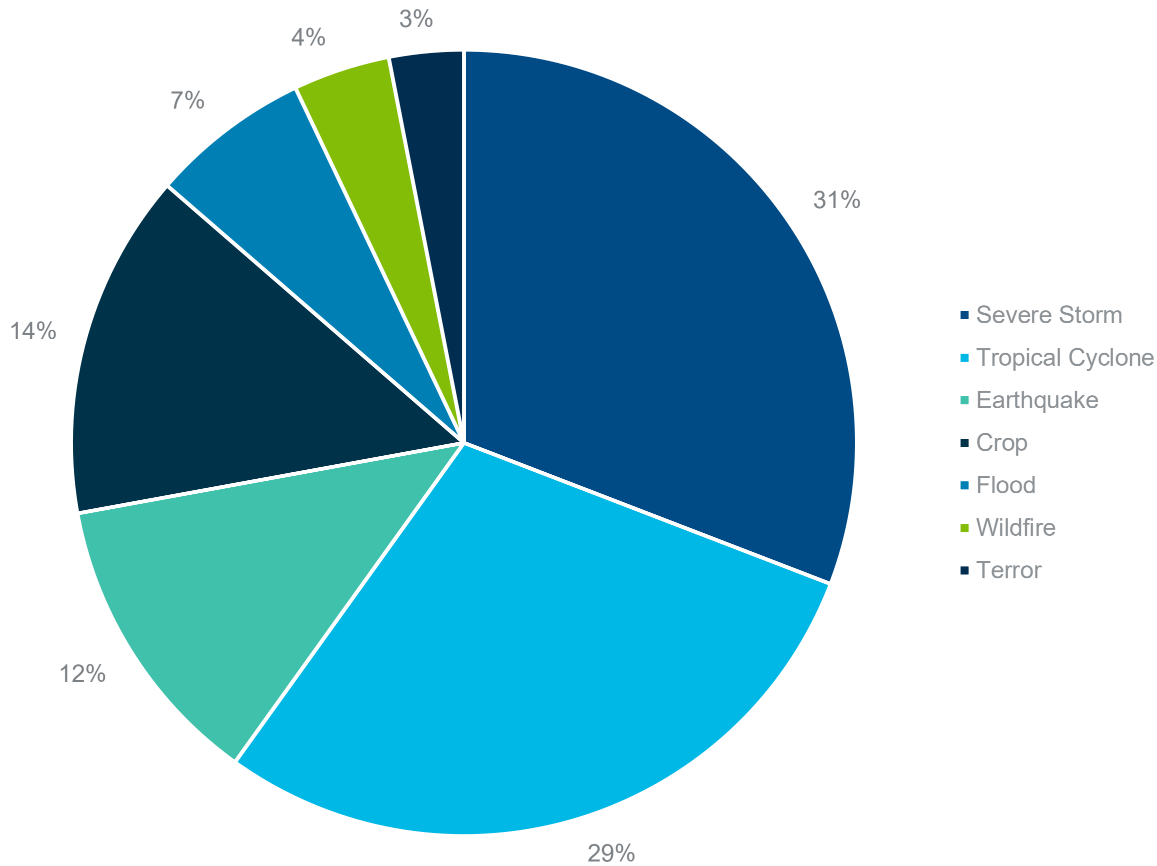

Figure 1. Contribution to global insured AAL by peril for all regions. (Source: AIR)

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

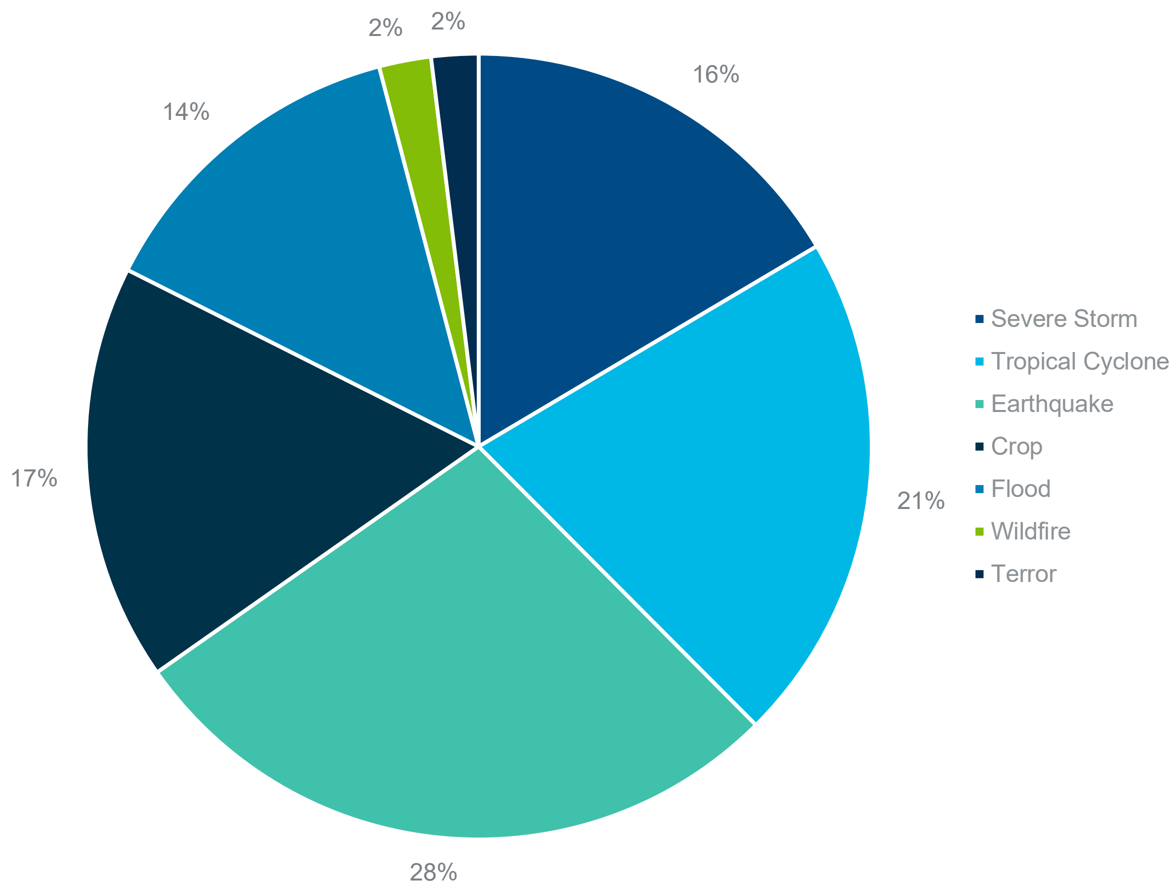

Figure 2. Contribution to global insurable AAL by peril for all regions. (Source: AIR)

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 40th-ranked event an EP of 0.004 (40/10,000) or 0.40%, the 100th-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 447 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	15.9	9%	176.7
Europe	14.1	22%	64.1
Latin America (the Caribbean, Central America, South America)	5.2	14%	37.1
North America (Canada, the United States, Bermuda, Mexico)	61.9	38%	162.9
Oceania	2.6	37%	7.0
All exposed areas	**99.6**	**24%**	**447.8** (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.

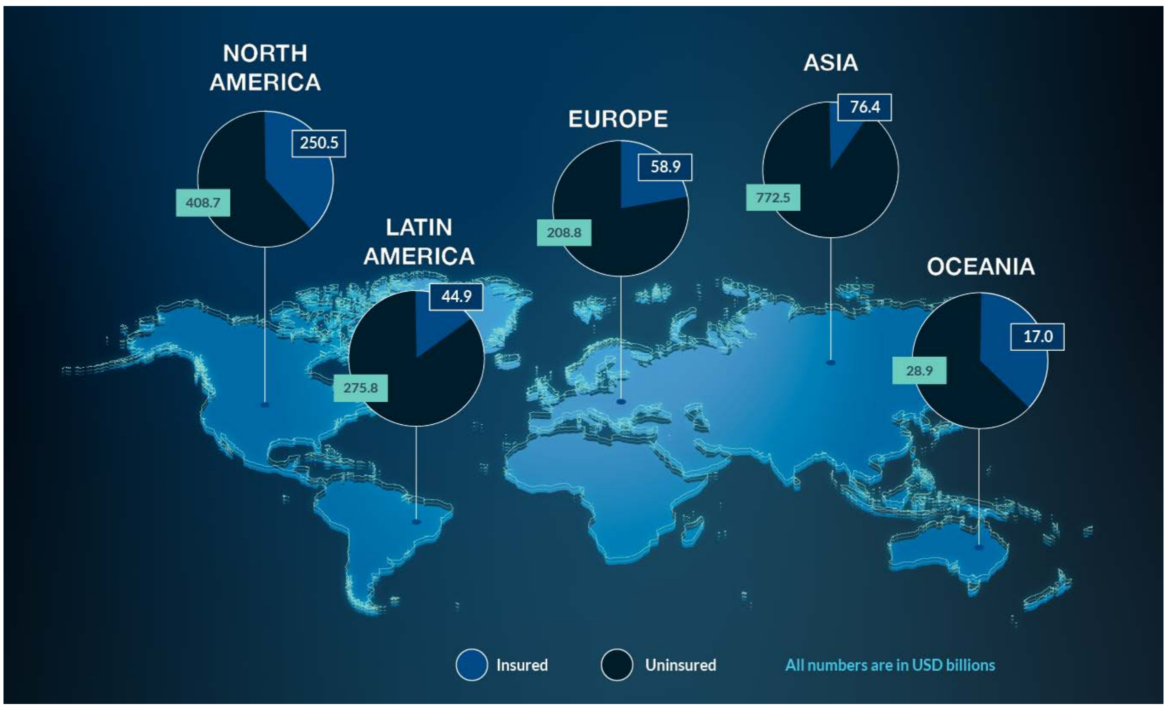

Figure 3. The gap between insured and total economic losses (the sum of insured and uninsured losses), by region, at the 1% exceedance probability (100-year return period) level. (Source: AIR)

To help close the protection gap, AIR launched our 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 93% of worldwide insured losses for the 20-year period from 2000 through 2019, as shown in Figure 4.

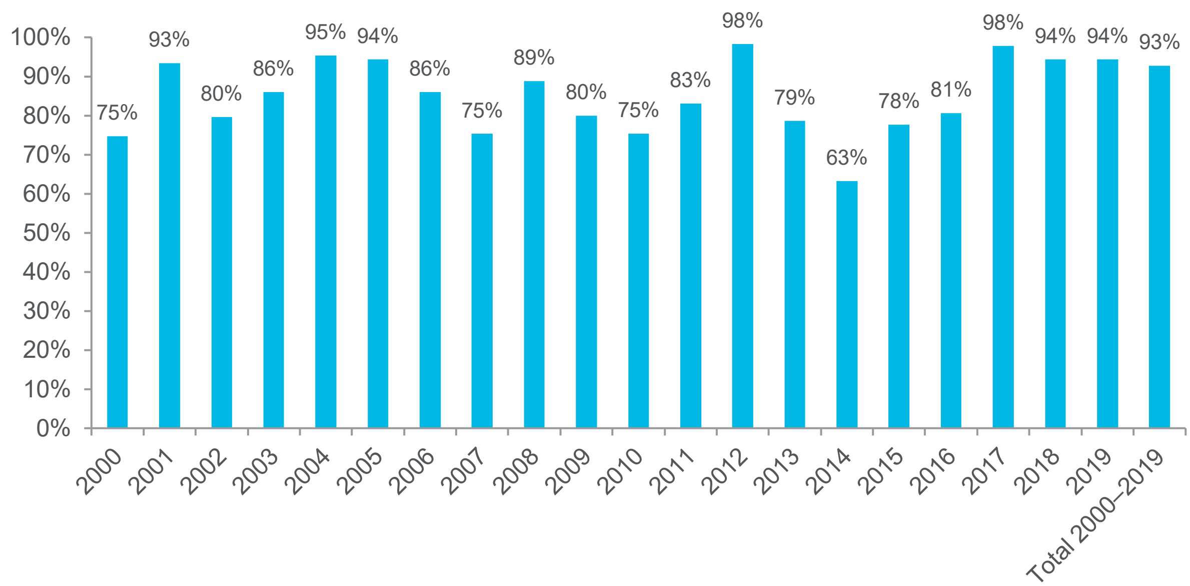

Figure 4. The percentage of reported insured losses covered by AIR's current suite of models, 2000–2016. (Source: AIR, Swiss Re, AXCO, Munich Re, PCS, Aon Benfield, PERILS)

As indicated in Figure 4, AIR models covered 94% of the global reported insured losses for 2019. Floods in Asia and Oceania accounted for the majority of non-modeled losses. The accumulation of these events, in addition to smaller non-modeled events that occurred in 2019, 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. Models on the roadmap include updated Japan earthquake and typhoon models, as well as updates to AIR's terrorism model and U.S. severe thunderstorm model. Expansion into climate change risk is also well under way. All AIR models reflect the current climate to better represent today's risk; we are including a chapter in our atmospheric perils' model documentation that discusses how climate change has been incorporated in each of them. In addition, AIR offers advanced solutions on a consulting basis for managing accumulations associated with supply chain and liability risks.

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

Because 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, supply chain disruptions, 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 https://www.air-worldwide.com. For more information about Verisk, a leading data analytics provider serving customers in insurance, energy and specialized markets, and financial services, please visit www.verisk.com.

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