Taking a Comprehensive View of Catastrophe Risk Worldwide

AIR's Global Exceedance Probability Curve

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The AIR Institute's
Certified Catastrophe
Modeler Program

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Contact Information

If you have any questions regarding this document, contact:

AIR Worldwide
131 Dartmouth Street
Boston, MA 02116-5134

USA

Tel: (617) 267-6645

Fax: (617) 267-8284

Table of Contents

Executive Summary

Insured losses from natural catastrophes in 2011 were significant. According to Swiss Re, 175 natural catastrophes—including earthquakes in Japan and New Zealand, flooding in Thailand, and swarms of tornadoes in the United States—produced the second highest insured loss tally,[1] USD 110 billion, since Swiss Re began publishing data in 1970[2].

While total global insured losses in 2011 may seem high, or notable for the number and variety of events that comprise them (15 individual catastrophes each exceeded USD 1 billion in insured loss), it falls near the 6.7% exceedance probability (or the 15-year return period) on AIR's global industry exceedance probability (EP) curve.

Furthermore, although last year's losses were significant, they did not cause the insolvency of a single company—a testament to an improved approach to catastrophe risk management, aided in no small part by the use of catastrophe models.

Nevertheless, the events of 2011 did prompt the insurance industry to consider how to put the losses in perspective. Basic questions that surfaced after 2011 and that will be explored in this paper, include: 1) how frequent are loss years like 2011; 2) what percentage of the losses were modeled; and finally, 3) are natural catastrophe events becoming more frequent and/or more severe?

AIR Worldwide (AIR) is in a unique position to provide guidance with respect to these questions. First, AIR develops and maintains detailed industry exposure databases (IED) for each modeled country. These IEDs serve as the foundation for all modeled *industry* loss estimates and make the generation of a **global industry exceedance probability curve** a straightforward task. Second, one of the key advantages of AIR's approach to generating the stochastic catalogs included in its models is that it enables the user to determine the probability of various levels of loss for single- or multiple-event *years* of catastrophe activity, across multiple perils and regions. Finally, AIR models the risk from natural catastrophes (and terrorism[3]) in more than 90 countries. This gives AIR a truly global perspective.

The discussion herein promotes awareness of AIR's global industry exceedance probability curve, two metrics of which—the average annual loss (AAL) and the 1% aggregate exceedance probability loss—are shown in Table 1. (Note that industry insured losses can and do occur in regions and from perils that AIR does not currently model; losses from these regions and perils are not included in AIR's global estimate, and as such, the exceedance probabilities for the various levels of loss in this report can be expected to be higher. The list of perils and regions that AIR's estimates reflect is available in Appendix 1.)

[1] 2011's insured losses were second only to those of 2005, when Hurricanes Katrina, Rita and Wilma *alone* resulted in claims of over USD 100 billion. In 2011, losses from U.S. hurricanes were moderate compared to the last decade.
[2] Swiss Reinsurance Company maintains a limited access global natural (excluding drought) and man-made disaster database.
[3] Terrorism is not included in analyses here, however.

Table 1. Key loss metrics from AIR's global industry EP curve

Exceedance Probability	Insured Loss (USD)
Average Annual Loss	59 billion
1% Aggregate Loss	206 billion

To provide additional context around the aggregate risk view on a global scale, this document also illustrates scenarios that could result in losses even greater than those of 2011; in particular, scenarios at the 1% aggregate exceedance probability (the 100-year return period) and the 0.4% aggregate exceedance probability (the 250-year return period). Also included are details about these scenarios, metrics from AIR's global EP curve and a comprehensive discussion to help risk managers contemplate a critical question: is the industry prepared for losses from natural catastrophes on a global scale?

2011: Natural Catastrophes at a Glance

USD 362 billion	Economic losses from natural catastrophes were the highest on record.
USD 110 billion	Insured losses were the second highest.
USD 49 billion	Earthquakes were the most expensive natural peril; indeed, insured earthquake losses, the majority of which resulted from Japan's Tohoku temblor, were higher than in any year ever.
USD 49 billion	Asia suffered the highest insured losses of any region—42.5% of the global total.
USD 35 billion	The Tohoku earthquake was the single highest insured loss-causing event.
USD 12 billion	The Thai floods and the M 6.3 Christchurch earthquake in New Zealand in February tied for the *second* highest insured losses.
Three (3)	Three natural catastrophes caused insured losses in excess of USD 10 billion.
Fifteen (15)	Fifteen natural catastrophes caused insured losses in excess of USD 1 billion.

Introduction: Global View of Risk as a Best Practice

Natural catastrophes spared few corners of the globe in 2011 and resulted in the highest *economic* losses for any year on record. The M9.0 Tohoku earthquake in Japan, earthquakes in New Zealand, flooding in Thailand, and a record-breaking severe thunderstorm season in the United States, along with other notable loss-causing natural catastrophes, caused *insured* losses of approximately USD 110 billion. This is the second highest insured loss on record. (By way of comparison, insured losses from natural catastrophes in the previous year, 2010, were less than half the 2011 total, at USD 40 billion; insured losses in Asia alone exceeded that number in 2011.)

Despite the significance of the toll from natural catastrophes in 2011, the resulting insured losses fall around the 6.7% exceedance probability (the 15–year return period) on AIR's global industry exceedance probability curve—*well within* the range of industry loss for which global insurers and reinsurers should be prepared. This should come as no surprise to companies who evaluate loss on a global scale, rather than a national or regional one.

For example, while the loss associated with the Tohoku earthquake (USD 35 billion) was thought to have an extremely low exceedance probability for that portion of Japan's Sendai coast, for Japan as a whole, it has a considerably higher exceedance probability, at roughly 0.90%. It has an even higher exceedance probability, roughly 4%, with respect to *global* earthquake risk.

Similarly, the annual probability of experiencing a Katrina-sized hurricane loss (USD 45 billion[4]) or higher in the state of Louisiana is about 0.08%, but it increases dramatically—to nearly 5%—when considering the U.S. as a whole.

Not surprisingly then, evaluating portfolio risk based on *regional* losses can significantly underestimate the actual risk for companies with global exposures. Yet this approach is not unheard of in the industry today; for example, companies are known to estimate their U.S. hurricane losses by region and purchase reinsurance to cover their largest regional loss. However, a look at the EP curves for other regions for which the company provides cover may show that farther out on these curves—beyond the 1% EP, for example—the company could experience losses at or above the worst *single* region's 1% EP loss. These higher losses will move the worst single region's 1% EP loss "down" the nationwide EP curve (toward higher exceedance probabilities) and raise the overall loss at the 1% EP. Indeed, in the end, a company's actual 1% exceedance probability loss may be much higher than the 1% loss in its worst single region.

While regional losses can be used when considering the purchase of regional reinsurance, companies with global exposures are likely to underestimate their global natural catastrophe risk if they use this approach instead of considering the global aggregate EP curve.

In addition to evaluating risk on a global scale, companies aiming to have a true understanding of their risk should follow other best practices with respect to interpreting catastrophe model results. For

[4] This value is based on 2009 exposure from AIR's industry exposure databases.

example, they should not look at only one peril (or one region) to assess the risk at a given exceedance probability. Indeed, if a company just considered their worst single peril and evaluated loss from this peril at the 1% exceedance probability, they could severely underestimate risk; this is because, in a given year, they could experience losses from two other perils equal to *or greater than* the 1% EP loss from their worst single peril. The aggregate exceedance probability curve, which sums losses from *all* events occurring in a simulated year, is a far better measure of portfolio risk.

	EV	5.00%	2.00%	1.00%	0.40%	0.20%	0.10%
Hurricane	78,508,811	339,071,187	503,429,518	693,817,715	959,262,565	1,092,055,628	1,303,179,422
	EV	5.00%	2.00%	1.00%	0.40%	0.20%	0.10%
Earthquake	27,120,338	158,879,967	264,089,927	405,934,077	742,971,254	983,646,511	1,141,000,940
	EV	5.00%	2.00%	1.00%	0.40%	0.20%	0.10%
Severe Thunderstorm	60,308,841	196,058,211	312,291,274	504,203,661	715,506,615	960,019,277	1,166,591,807

	EV	5.00%	2.00%	1.00%	0.40%	0.20%	0.10%
Combined Perils	165,937,990	430,705,438	655,847,183	866,008,366	1,116,176,497	1,318,694,700	1,685,204,827

Figure 1. If Company A just considered its worst single peril, hurricane, and managed to a 1% probability of loss, it would be managing to losses of approximately USD 700M. Because it could experience combined earthquake and severe thunderstorm losses that size or greater, this approach underestimates the risk; indeed, the true 1% loss on the combined peril curve is more than USD 866 million—nearly 25% higher than the 1% EP loss for hurricane alone. (Source: AIR)

The emphasis on aggregate losses is important. Companies assessing the risk across all regions and perils should avoid the assumption that occurrence losses are a guide to the behavior of aggregate losses; the 1% occurrence EP and 1% aggregate EP losses rarely occur in the same year. A single-event year with a large loss-causing event (the 1% occurrence loss event, for example) will not appear at the 1% loss mark on the aggregate EP curve if—in the years being analyzed—there are many multi-event years with smaller but still significant loss-causing events.

Finally, just quantifying the difference between aggregate and occurrence losses is not sufficient. To truly manage global aggregate risk, it is important to recognize that many combinations of events—different perils in different regions—can produce similar levels of loss. Thus, aggregate losses around the 1% exceedance probability will be similar but made up of very different event compositions. To assist users in seeing what kinds of events drive their aggregate losses, AIR explicitly simulates years of event activity and includes this information in each model's catalog. Accordingly, users can employ AIR software to unambiguously calculate the aggregate loss in a given year; they simply sum the loss-causing events in each simulated year. This not only allows users to see what events drive their aggregate losses, it also helps them evaluate alternative reinsurance options (for example, protecting against an accumulation of smaller losses via some form of aggregate cover or perhaps taking on a second reinstatement to guard against the possibility of three major events in a year.)

As 2011 proved, catastrophe risk can take quite a toll on insurance and reinsurance companies who are globally exposed. Such companies need to ensure they fully grasp their far-reaching risk profile. They must ascertain they have enough capital to survive years of very high loss—potentially significantly higher than we saw in 2011. They must also understand how frequently they will face such years, as well as the variety of events that could comprise them, including contributions from non-peak regions and perils. Finally, they need to be prepared for the possibility that future catastrophes will produce losses exceeding any historical amounts.

The following sections provide output from AIR’s global exceedance probability curve, which can be used to effectively benchmark and manage natural catastrophe risk in the more than 90 countries worldwide for which AIR currently provides models.

Building an Exceedance Probability Curve

AIR's suite of catastrophe models provides a wide range of modeled loss output to suit the diverse needs of model users. One of the most commonly used types of output is a distribution of potential losses along with associated probabilities of exceedance, called an exceedance probability (EP) curve. Companies use EP curves—which can be peril- or region-specific—to quantify the risk profile for whole portfolios or for individual risks, and ultimately, to determine what amount of risk to keep and how much to cede away.

To understand how an AIR exceedance probability curve is generated, one must first understand how AIR develops its stochastic catalogs of simulated events. AIR scientists gather information on historical events from various sources in order to infer what can happen in the future. The stochastic catalog answers the questions of where and how frequently certain types of events are likely to occur and how large or severe they are likely to be. A 10,000-year hurricane catalog, for example, contains 10,000 potential realizations of what an upcoming year of tropical cyclone activity may look like. While the simulated events have their basis in historical data, they extend beyond the scope of past recorded experience in order to provide the full spectrum of future potential catastrophe events.

To generate an exceedance probability curve, an AIR catalog is run against a portfolio of high-resolution exposure. Next, AIR software outputs the loss by event for all simulated years. This information can be used to calculate the probability of exceedance of various levels of loss, on either an annual occurrence basis or an annual aggregate basis. To do this, losses are ranked from highest to lowest based on the largest event loss within each simulated year (the occurrence loss) or based on the sum of all event losses within each simulated year (the aggregate loss). The exceedance probability corresponding to each loss is equal to its rank divided by the number of years in the catalog. (To read more about how exceedance probability curves are constructed and how they should be interpreted, please see the AIR Current, Modeling Fundamentals: Combining Loss Metrics.)

The AIR approach for generating a stochastic catalog makes it straightforward to determine the probability of particular outcomes, either for the industry as a whole or for individual company portfolios; the probability of experiencing a hurricane season with four or more events, for example, can be determined simply by counting the number of years in the catalog with four or more events and dividing that number by the total number of years in the catalog.

Recall that exceedance probability curves provide the probability of a certain size loss, not the probability that a specific event will occur. This is because the probability of an actual event occurring exactly as simulated (or the exact recurrence of an historical event) is virtually zero. However, a wide range of events may cause a similar level of *loss*.

Guidance With Respect to Global Insured Losses

AIR is uniquely positioned to provide guidance with respect to the industry's questions about global losses that surfaced in the aftermath of 2011, including:

- What percentage of the global insured loss experienced in 2011 was captured by the models?
- More broadly, what percentage of the global industry insured loss that resulted in the last decade was modeled?
- How frequent are global loss years like 2011?
- And finally, are natural catastrophe events becoming more frequent and severe?

There is considerable discussion in the industry about how to handle the risk from non-modeled perils and regions. AIR's aggressive research roadmap is designed to address these concerns with, for example, the introduction of the industry's first tsunami modeling capability scheduled for release in 2013 and several fully probabilistic flood models in development. Nevertheless, AIR's existing suite of models—which today encompasses more than 90 countries—covers events representing over 80% of worldwide insured losses in 2011. Over the ten-year period from 2001 to 2011, the percentage is even higher: AIR's models cover events representing over 86% of insured losses from global natural catastrophes (Figure 2).

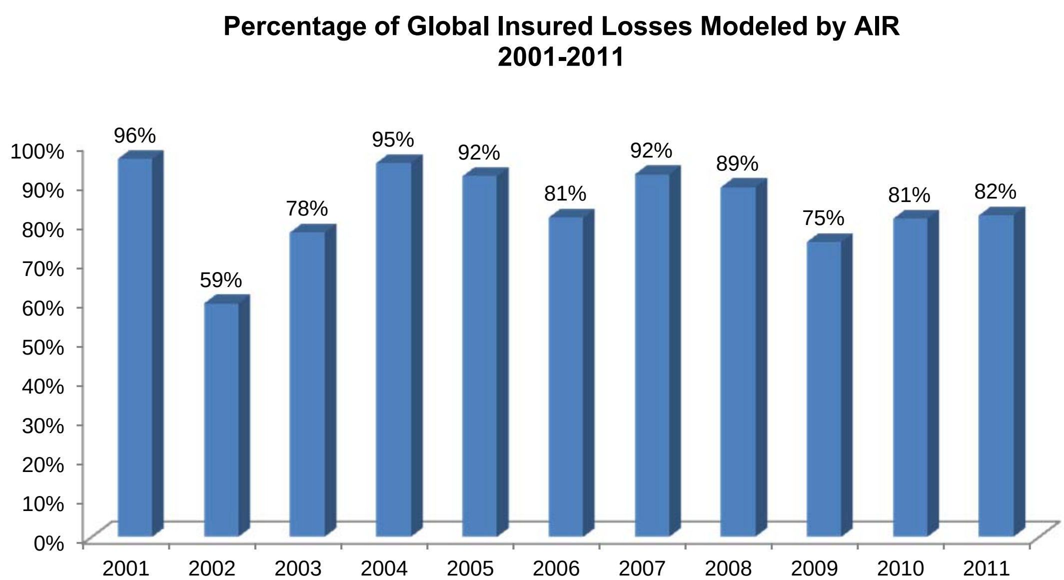

Figure 2. AIR's current suite of models cover more than 86% of insured losses from global natural catastrophes between 2001 and 2011. (Source: AIR, Swiss Re, AXCO, Munich Re)

AIR's insight into global industry insured losses continues with the detailed industry exposure databases (IEDs) that are developed from the ground up for all modeled countries. These IEDs contain counts of all insurable properties and their respective replacement values, along with information about occupancy and the physical characteristics of structures. (To read more about how AIR's detailed databases are created and how they form the foundation for all modeled industry loss estimates, see the AIR Current, The AIR Industry Exposure Databases.)

A Bottom-Up, Top-Down Methodology

AIR builds its industry exposure databases from the bottom-up, compiling detailed data about risk counts, building attributes (parameters that greatly influence the ability of a structure to withstand high winds, ground motion, or flood depth), as well as replacement values and information on standard policy terms and conditions. Once the risk counts for every insurable property have been identified, a top-down approach using aggregate data from multiple additional sources is taken to validate key attributes of the database. The advantage in coupling these approaches is the development of an aggregated industry-wide database that is both objective and robust.

The detailed IEDs AIR develops and maintains can be used to put the global losses of 2011—or any year, for that matter—in perspective. AIR's detailed IEDs make generating industry insured exceedance probability curves on the global scale straightforward.[5] Note that the loss estimates generated using the IEDs are benchmarked against information from various insurance industry and governmental sources. Thus, the IEDs are critical to the model validation process.

The next section evaluates total insured losses from 2011 in the context of AIR's global EP curve. Recall that, as discussed above, AIR's global EP curve is not comprehensive for all perils; rather, only for AIR-modeled perils, a list of which can be found in Appendix 1: Modeled Perils and Regions.

A Global Perspective on 2011

To read more about how AIR's global exceedance probability curve is generated using AIR software, please see Appendix 4. Table 2 provides two key metrics from this curve: the average annual aggregate insured loss and the 1% aggregate exceedance probability loss for all perils in all regions of the world and for several key regions. (Note that the countries comprising the key regions are colored, in Appendix 1: Modeled Perils and Regions, to match the color of each region as it is listed below).

[5] Note that IED indexes can be applied for 18 select countries, as described here: AIR Industry Exposure Databases for Select Countries.

Table 2 Global AAL and 1% exceedance probability insured loss by region* (Source: AIR)

All Perils by Area	Average Annual Aggregate Loss (USD)	1% Aggregate EP Loss (USD)
All Exposed Areas	59 billion	206 billion
Asia	**7.4 billion**	**54 billion**
Europe	**8.4 billion**	**50 billion**
Latin America	**6.6 billion**	**51 billion**
North America	**35 billion**	**169 billion**
Oceania	**1.7 billion**	**22 billion**

**Color codes correspond to region definitions provided in Appendix 1.*

On AIR's global exceedance probability curve, the AAL (USD 59 billion[6]) corresponds to an exceedance probability of approximately 35%. In other words, the global AAL has a 35% probability of being exceeded in a given year. Note that insured losses in 2011, at USD 110 billion, were nearly *double* the global AAL value, corresponding to a 6.7% exceedance probability. That is, in a given year, global losses like those experienced in 2011 have a 6.7% probability of being exceeded.

Even as companies understand the potential for loss years like 2011, they continue to question just what drives them. Indeed, a question commonly posed by researchers and risk managers alike is whether natural catastrophes are becoming more frequent and severe. In AIR's view, there is little evidence for this. During the current period[7] of warmer-than-average Atlantic sea-surface temperatures (SSTs), for example, 32 loss-causing hurricanes impacted the U.S. Some years saw landfall counts closely aligned with the view of risk reflected in AIR's warm-SST conditioned catalog. The current final tally, however, closely agrees with AIR's standard long-term view of U.S. hurricane risk, which considers all years since 1900.

It is AIR's view that increases in natural catastrophe-related losses are primarily driven by the increase in and distribution of exposures in areas susceptible to natural perils. As the number of properties in highly-exposed areas of the world and the overall penetration of insurance increase, insured losses from natural catastrophes will only continue to rise.

[6] By comparison, Swiss Re's AAL for global natural catastrophes from 2001 to 2011 is approximately USD 48.3 billion; this value is trended to 2011 dollars.
[7] Since 1995.

Global Industry Insured Loss Scenarios around the 1% Exceedance Probability

As noted in Table 2, the 1% aggregate exceedance probability loss on AIR's global EP curve is just over USD 200 billion. Many combinations of events—different perils in different regions—could produce this level of loss. Because understanding large aggregate loss years helps companies evaluate alternative reinsurance options, it is important to not only quantify the loss at this level, but to consider the variety of events that can produce it in any given year.

Indeed, if a company evaluating losses to its portfolio were to select a range of years with aggregate annual losses around the 1% exceedance probability point, it could expect roughly the same loss level in each but—more than likely—very different event compositions.

Typically, companies with global exposures may expect losses at the 1% exceedance probability point to include substantial contribution from U.S. hurricane events. While this scenario is indeed likely, insured loss at the 1% exceedance probability can also be driven by non-peak perils and by perils occurring in non-peak regions. Risk managers of global companies need to be aware that their global losses may not be driven by a single event. Indeed, in 2011, there were fifteen events for which insured losses exceeded USD 1 billion and three for which insured losses exceeded USD 10 billion.

The following three examples describe in detail years at or near the 1% exceedance probability on AIR's global industry EP curve, each of which is made up of different possible combinations of natural catastrophes worldwide. (It is important to note, however, that this level of loss can be achieved by any number of combinations of individual events.)

Loss Scenario 1

The first year in this analysis represents what many companies have always planned for: a severe hurricane impacting the southeastern United States, including Florida. In this simulated year—which generates total industry insured losses of more than USD 207 billion—a Category 4 Hurricane causes more than USD 158 billion in insured loss in Cuba, Haiti, the Bahamas, Florida, and the Gulf of Mexico; this particular storm has an unusual track, recurving southeast into the Atlantic after exiting Florida, where it impacts both the south of the state and Tampa, to the north. Another large hurricane, a Category 3 event, causes more than USD 11 billion in insured loss in the Gulf of Mexico and Texas; the storm makes landfall just south of the Houston/Galveston area, in Texas, and goes on to cause loss in Louisiana. Hurricanes alone cause 86% of the year's insured loss. The remaining 14% come largely from earthquake events scattered around the globe and severe thunderstorm events in North America.

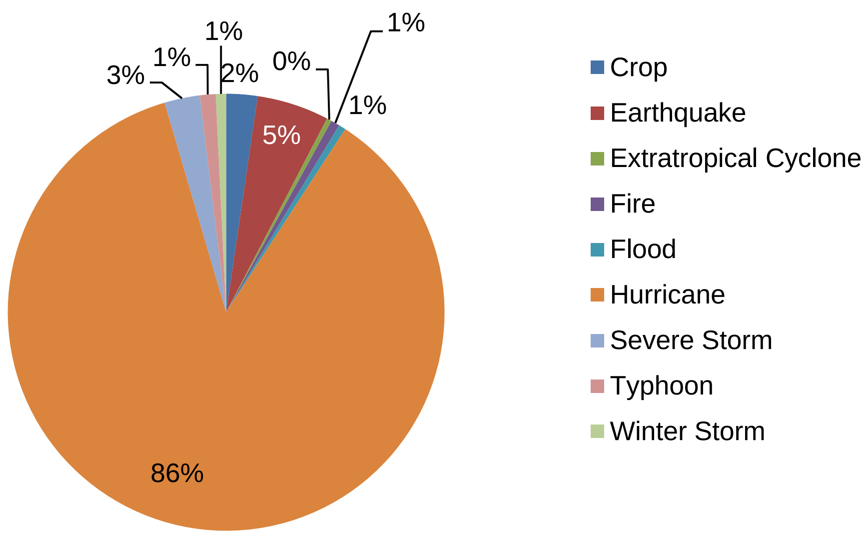

Figure 3. Breakdown of losses by peril for loss scenario 1. (Source: AIR)

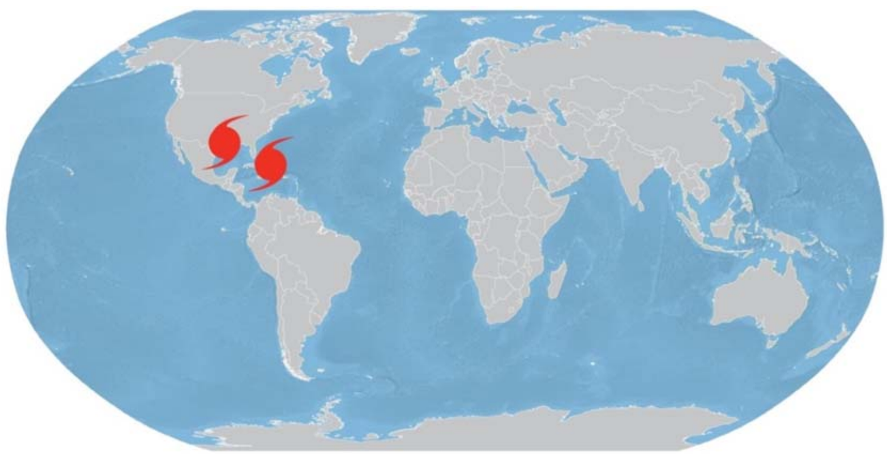

Figure 4. In this simulated year, more than 86% of insured loss results from hurricanes in North America. (Source: AIR)

Table 3. Two events cause losses in excess of USD 10 billion. (Source: AIR)

Event	Areas Affected	Insured Losses
Category 3 hurricane	Texas, Gulf of Mexico, Louisiana	USD 11 billion
Category 4 Hurricane	Cuba, Haiti, Bahamas, Gulf of Mexico, Florida	USD 158 billion

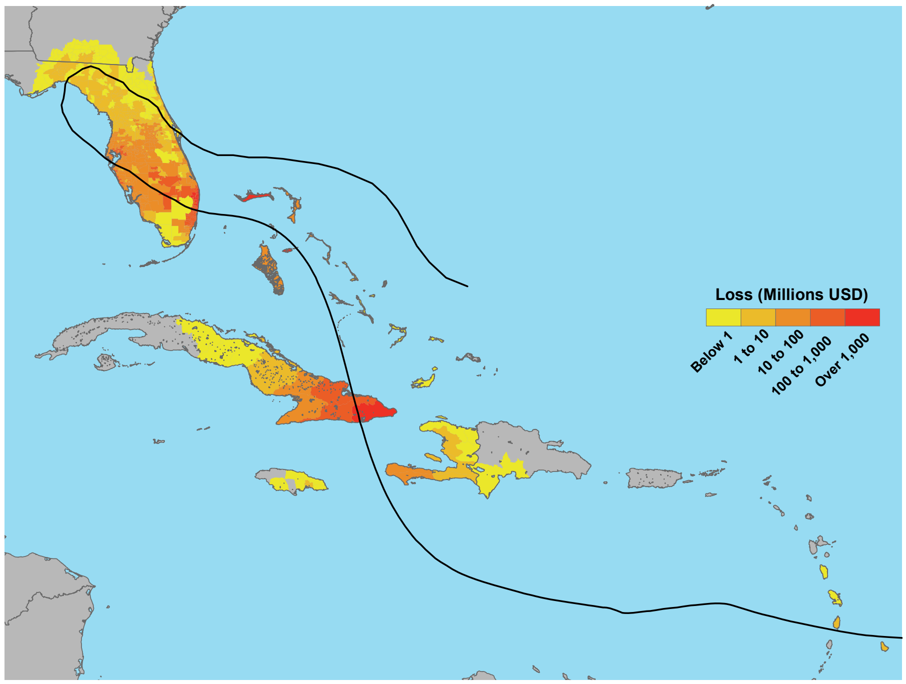

Figure 5. A Category 4 hurricane causes more than USD 158 billion in insured loss in Cuba, Haiti, the Bahamas, the Gulf of Mexico, and Florida. (Source: AIR)

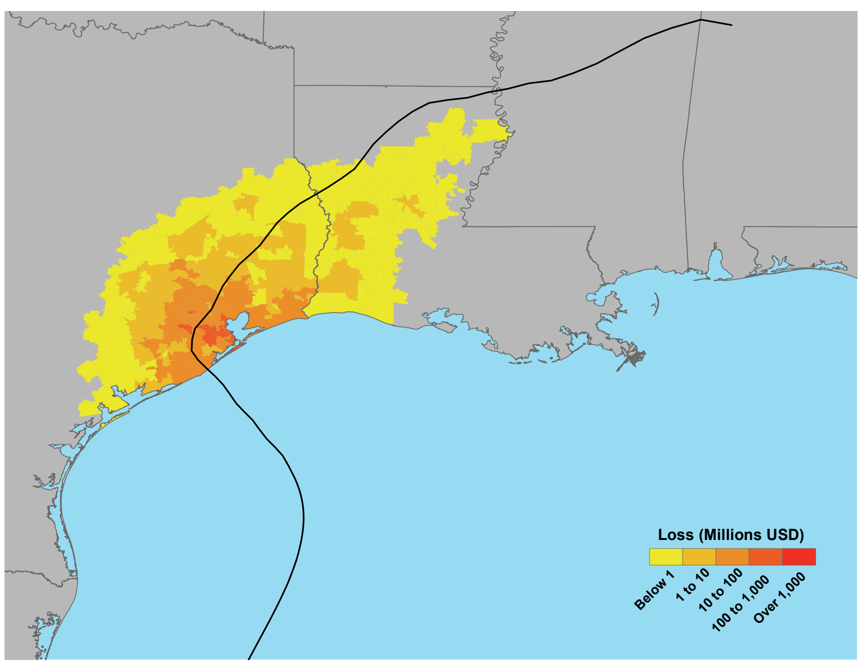

Figure 6. A Category 3 hurricane causes more than USD 11 billion in insured loss in Texas, the Gulf of Mexico, and Louisiana. (Source: AIR)

Loss Scenario 2

The second year in this analysis represents a very different scenario. In this simulated year—which generates total industry insured losses of just under USD 200 billion—hurricanes impact North America, Mexico, the Caribbean, and Australia, but drive only 60% of the year's insured loss (as compared to 86% in the previous scenario). The majority of the remaining loss comes from extratropical cyclones (ETC) and floods in Europe, including an ETC that causes more than USD 14 billion in insured loss in Sweden, Denmark, Germany, Poland, and the United Kingdom, and a flood that causes more than USD 10 billion in insured loss in England.

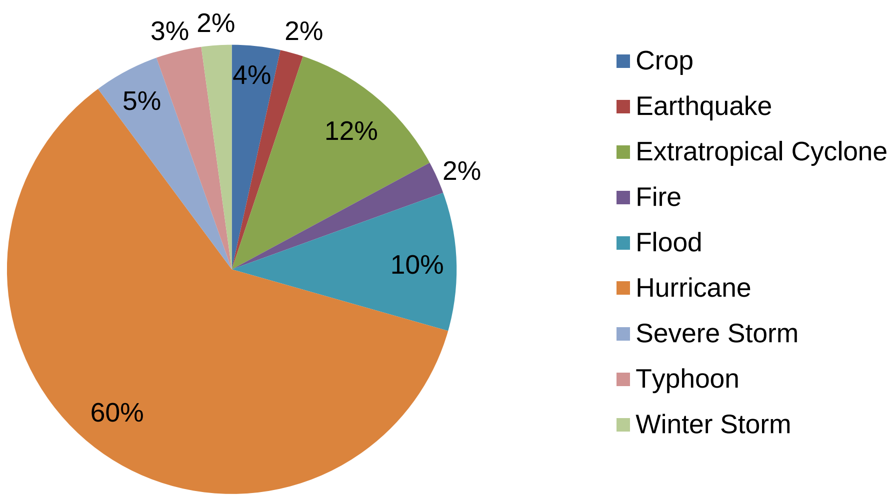

Figure 7. Breakdown of losses by peril loss scenario 2. (Source: AIR)

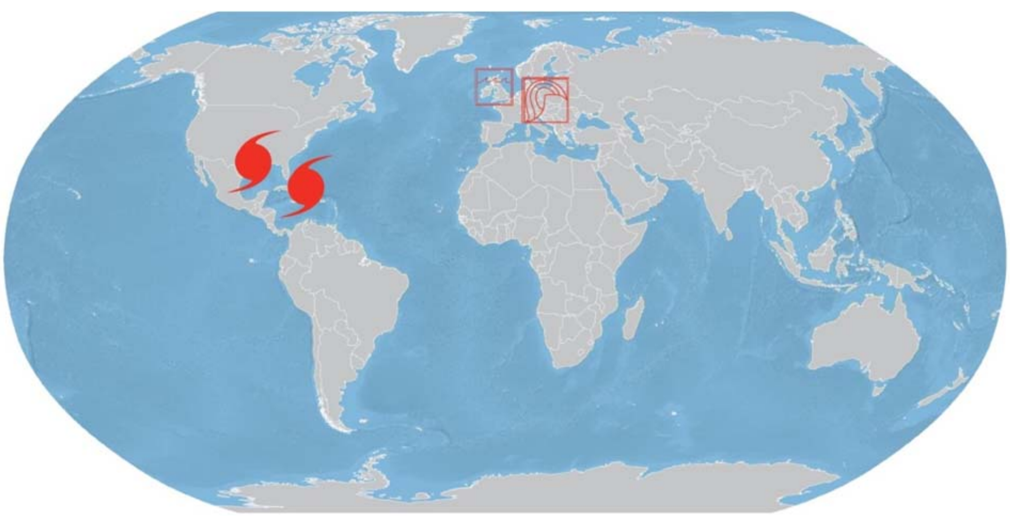

Figure 8. In this simulated year, hurricanes in North America, Mexico, the Caribbean, and Australia drive 60% of the year's insured loss; the majority of the remaining loss comes from extratropical cyclones and floods in Europe. (Source: AIR)

Table 4. Four events cause insured losses in excess of USD 10 billion. (Source: AIR)

Event	Areas Affected	Insured Losses
Flood	England (Southwest London, Southeast London, West London, Twickenham, Oxford)	USD 10 billion
Extratropical cyclone	Sweden, Denmark, Germany, Poland, United Kingdom	USD 14 billion
Category 3 hurricane	Cayman Islands, Cuba, Gulf of Mexico, Texas, Louisiana	USD 34 billion
Category 4 hurricane	Cuba, Bahamas, Gulf of Mexico, Florida, Alabama	USD 78 billion

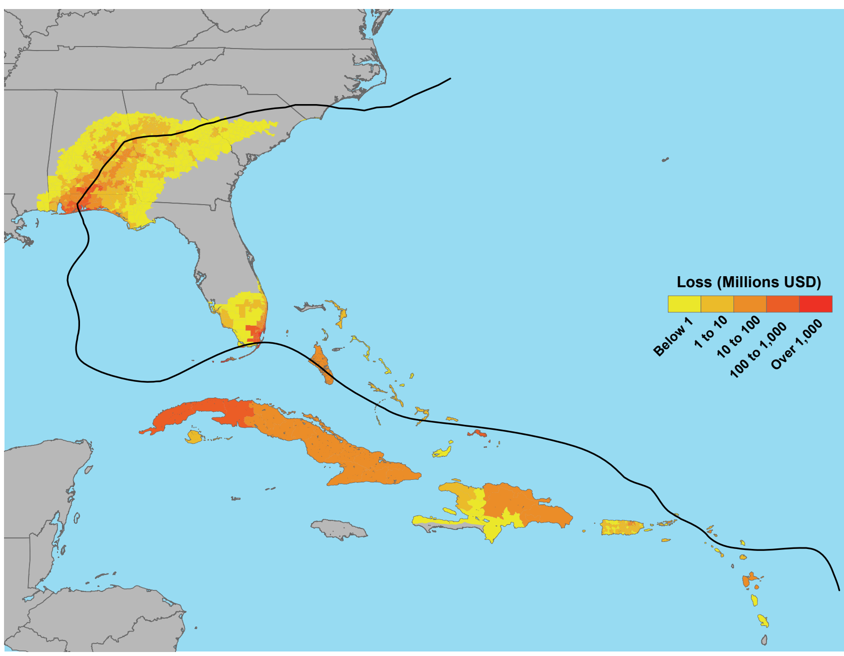

Figure 9. A Category 4 hurricane causes more than USD 78 billion in insured loss in Cuba, the Bahamas, the Gulf of Mexico, Alabama, and Florida. (Source: AIR)

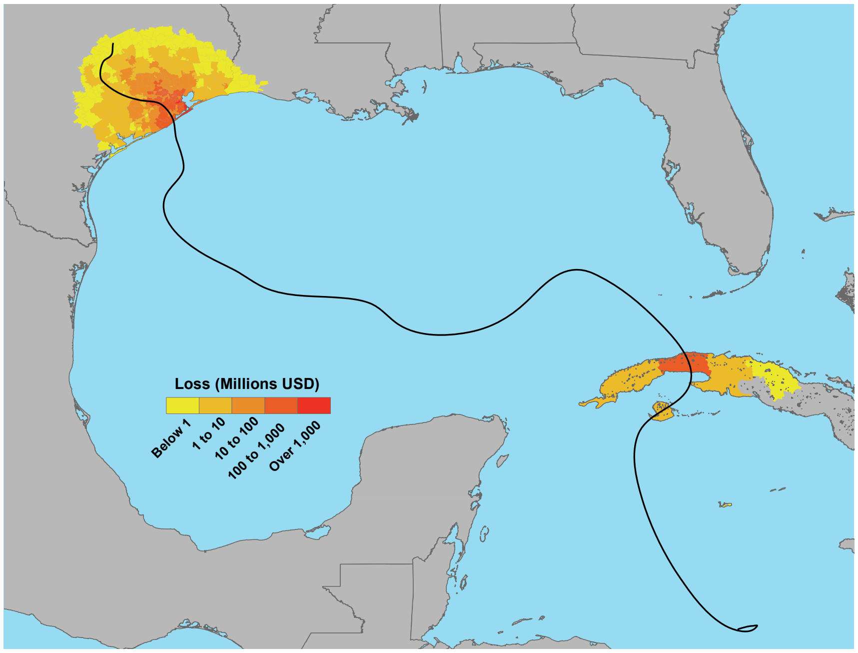

Figure 10. A Category 3 hurricane causes more than USD 34 billion in insured loss in the Cayman Islands, Cuba, the Gulf of Mexico, Texas, and Louisiana. (Source: AIR)

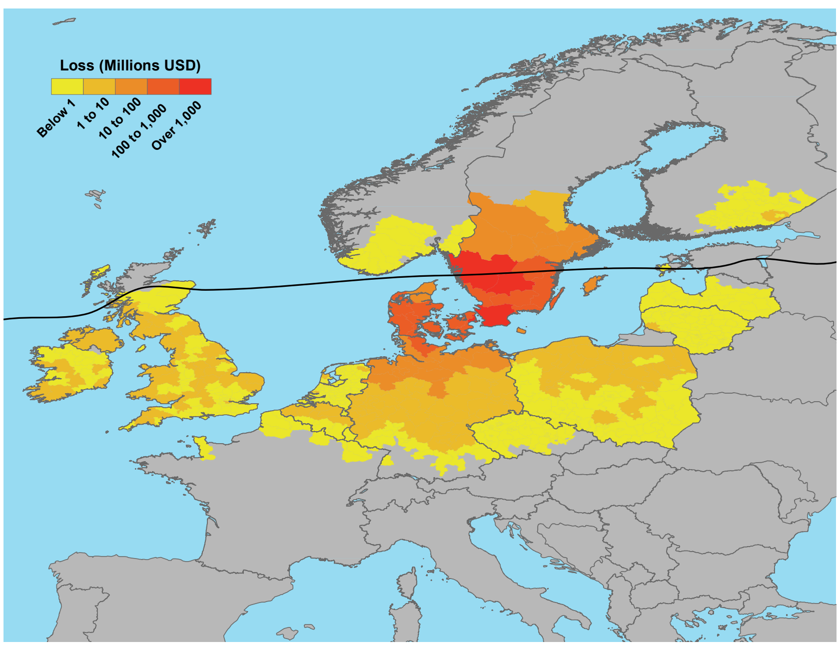

Figure 11. An extratropical cyclone causes more than USD 14 billion in insured loss in Sweden, Denmark, Germany, Poland, and the United Kingdom. (Source: AIR)

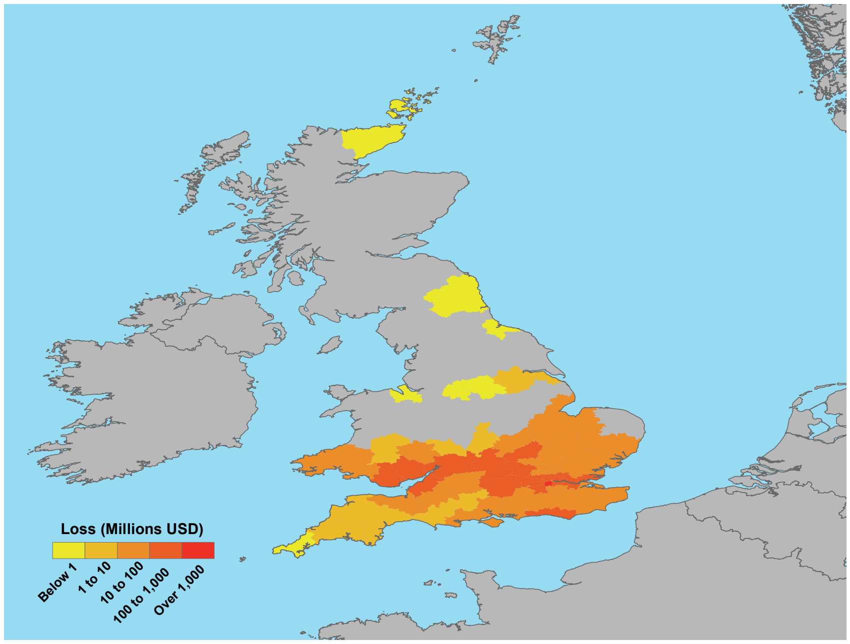

Figure 12. A flood causes more than USD 10 billion in insured loss in England in Southwest London, Southeast London, West London, Twickenham, and Oxford. (Source: AIR)

Loss Scenario 3

The third year in this analysis represents yet another scenario. In this simulated year—which generates total industry insured losses of just under USD 198 billion—a magnitude 8.7 earthquake impacts the Japanese commercial hub of Osaka in Osaka Prefecture, as well as the prefectures of Aichi, Kōchi, Hyōgo, and Mie. Insured losses from earthquake events in Asia and other regions make up 85% of the year's losses. The majority of the remaining loss is scattered between losses from hurricane events, severe thunderstorm events, and crop damage. Note that this simulated year—with the greatest proportion of losses coming from Asia, and also from earthquake events—is similar to 2011, though it is far more extreme (in this simulated year, 60% of losses were driven by events in Asia, as opposed to 42.5% in 2011, and 85% of losses were from earthquake events, as opposed to roughly 44.5% in the 2011 loss tally).

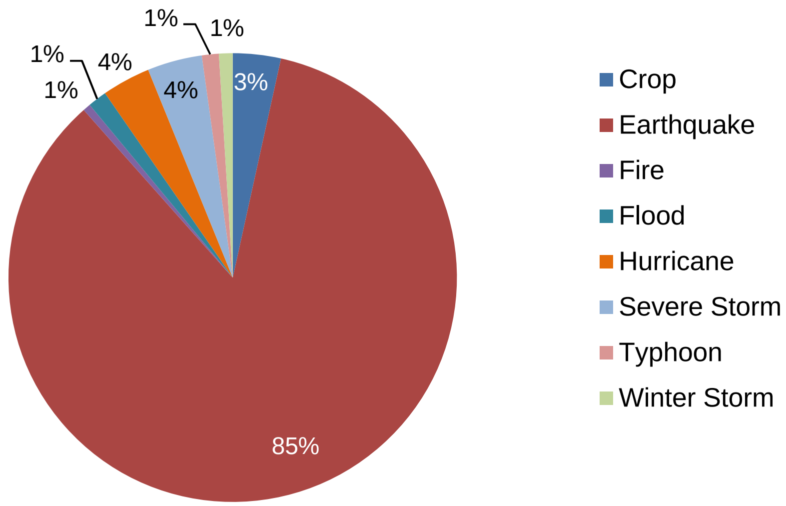

Figure 13. Breakdown of losses by peril for loss scenario 3 (Source: AIR)

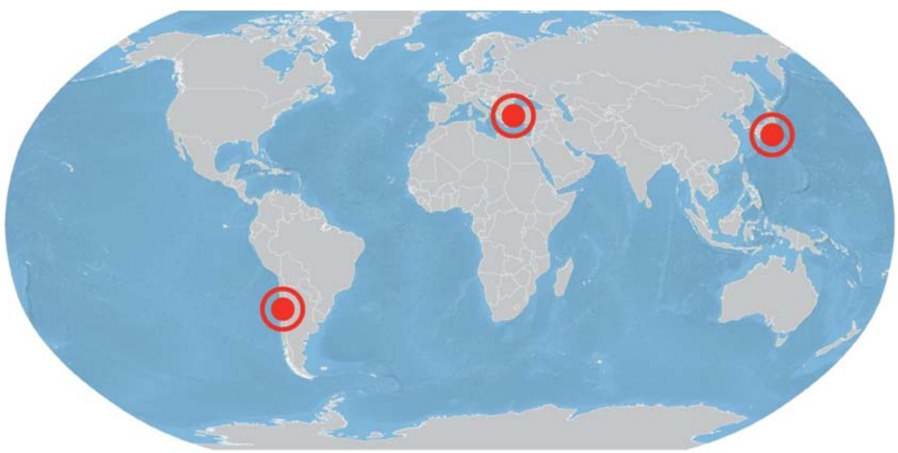

Figure 14. In this simulated year, earthquakes produce 85% of insured losses. (Source: AIR)

Table 5. Three events cause insured losses in excess of USD 10 billion. (Source: AIR)

Event	Areas Affected	Insured Losses
M 7.7 earthquake	Turkey, Greece, Bulgaria	USD 14 billion
M 7.6 earthquake	Chile	USD 35 billion
M8.7 earthquake	Japan	USD 114 billion

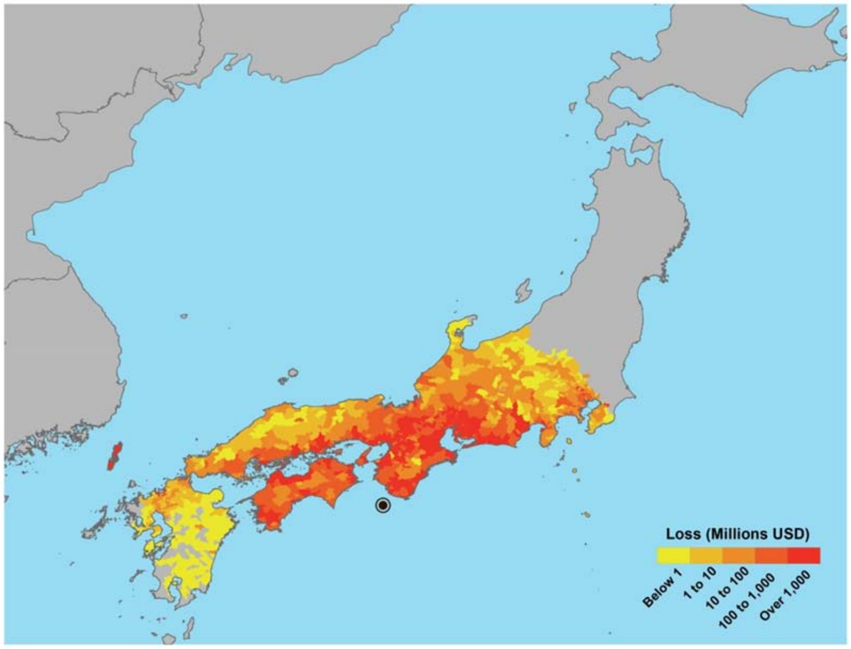

Figure 15. A magnitude 8.7 earthquake in Japan causes more than USD 114 billion in insured loss in the prefectures of Osaka, Aichi, Kōchi, Hyōgo, and Mie. (Source: AIR)

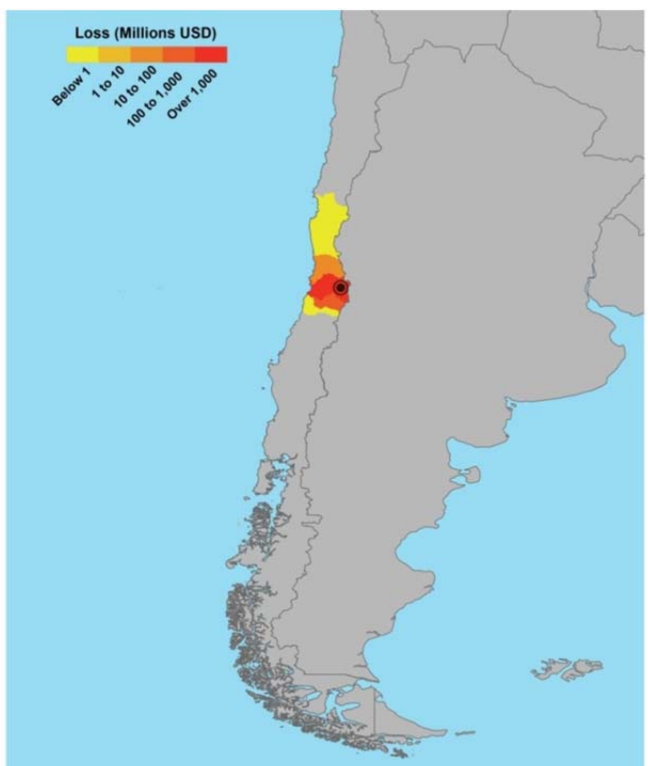

Figure 16. A magnitude 7.6 earthquake in Chile causes more than USD 35 billion in insured loss in regions including Santiago, the country's capital. (Source: AIR)

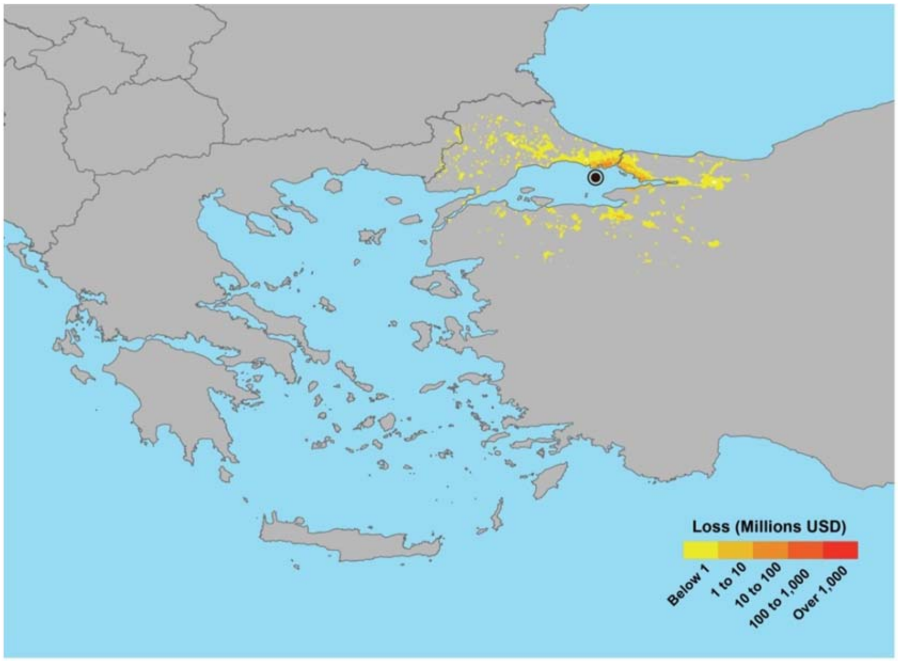

Figure 17. A magnitude 7.7 earthquake causes more than USD 14 billion in insured loss mostly in Turkey, but also in Greece and Bulgaria. (Source: AIR)

Global Industry Insured Loss Scenario around the 0.4% Exceedance Probability

The 0.4% exceedance probability on AIR's global industry exceedance probability curve corresponds to a USD 265 billion loss. Again, this *level* of loss could occur as a result of any number of combinations of events. This section speaks to one possible combination.

In the simulated year in this example, there are several notably severe events that produce the final loss amount, including a USD 155 billion earthquake in San Francisco, a USD 39 billion earthquake in Tokyo, and a USD 29 billion hurricane that tracks mostly through the Caribbean. These three events *alone* cause more than 84% of the year's insured loss. The remaining 16% comes from more than 200 other catastrophic events, including more than 40 U.S. severe thunderstorm events that produce losses in excess of USD 19 billion.

Conclusion

Catastrophe risk can threaten a company's financial well-being. Companies operating on a worldwide stage need to understand their risk across global exposures and ensure they have sufficient capital to survive even years of very high loss. They must understand the likelihood of facing such years—as well as the diversity of events that could produce such losses. Finally, companies with global exposures and an expanding global reach need to be prepared for the possibility that future catastrophes will produce losses exceeding any historical amounts.

To do this effectively, companies can use the global exceedance probability metrics generated with AIR software to benchmark and manage natural catastrophe risk in more than 90 countries around the globe.

With the insight provided from AIR's offerings, companies can pursue profitable growth in a market that is ever more connected—and amid regulatory environments that are ever more rigorous—with greater confidence that the risk they have assumed is risk they can afford to take.

Appendices

Appendix 1: Modeled Perils and Regions

EARTHQUAKE

North America	Caribbean	Central America	South America	Pan-European		Asia-Pacific
Alaska Canada Hawaii Mexico United States *(contiguous)*	Bahamas Barbados Cayman Islands Dominican Republic Jamaica Puerto Rico St. Maarten St. Martin Trinidad and Tobago U.S. Virgin Islands	Belize Costa Rica El Salvador Guatemala Honduras Nicaragua Panama	Chile Colombia Peru Venezuela	Austria Belgium Bulgaria Cyprus Czech Republic Denmark Estonia Finland France Germany Greece Hungary Ireland Israel Italy	Latvia Lithuania Luxembourg Monaco Netherlands Norway Poland Portugal Romania Slovakia Slovenia Sweden Switzerland Turkey United Kingdom	Australia China Japan Indonesia New Zealand Philippines Republic of Taiwan

TROPICAL CYCLONES (HURRICANES, TYPHOONS)

North America	Central America**	Caribbean**	Asia-Pacific
Hawaii Gulf of Mexico (Offshore Assets) Mexico** United States* *(29 hurricane states and the District of Columbia)* ** includes coastal storm surge* *** includes precipitation-induced flooding*	Belize Costa Rica El Salvador Guatemala Honduras Nicaragua Panama	Anguilla Antigua & Barbuda Aruba Bahamas Barbados Bermuda British Virgin Islands Cayman Islands Cuba Dominica Dominican Republic Grenada Guadeloupe Haiti Jamaica Martinique Montserrat Netherlands Antilles Puerto Rico Saint Barts, Saint Kitts & Nevis St. Lucia St. Maarten St. Martin St. Vincent & the Grenadines Trinidad & Tobago Turks & Caicos Island U.S. Virgin Islands	Australia*, ** China** Hong Kong** India** Japan** Philippines** Taiwan** South Korea**

EXTRATROPICAL CYCLONES (WINTER STORMS)

North America	Europe
United States	Austria Belgium Czech Republic Denmark Estonia Finland France Germany Ireland Latvia Lithuania Luxembourg Netherlands Norway Poland Sweden Switzerland United Kingdom* **includes coastal storm surge*

CROP LOSS

China United States

INLAND FLOOD*

Germany Great Britain **AIR also models losses from tropical cyclone induced precipitation in North America, the Caribbean, Central America and the Asia-Pacific region*

WILDFIRE

North America	Asia-Pacific
California	Australia

TERRORISM

United States* **AIR has the added capability, on a consulting service basis, of analyzing terrorism risk both deterministically and probabilistically in any country*

SEVERE THUNDERSTORM

North America
Canada United States

Appendix 2: Information Regarding what AIR Loss Estimates Reflect

In general, AIR modeled loss estimates reflect damage from the perils and in the regions listed in Appendix 1. The loss estimates reflect elements including but not limited to:

- Insured physical damage to property (residential, commercial, industrial, auto), both structures and their contents.
- Time element coverage (additional living expenses for residential properties and business interruption for commercial properties).
- Demand surge across regions and perils.

AIR estimates do not include perils such as earthquake-induced landslides or hurricane-induced riverine flooding, nor do they include losses from inflation due to political pressure, hazardous waste cleanup, vandalism or civil commotion, whether directly or indirectly caused by the event in question.

For a full and comprehensive list of perils, coverages, and loss components that AIR's loss estimates do and do not reflect, AIR recommends reading the technical documentation available on our website.

Appendix 3: Scenario Years Corresponding to Previously Described Simulated Loss Scenarios

The event described in the Global Industry Insured Loss Scenarios around the 1% Exceedance Probability, Loss Scenario 1 section corresponds to aggregate year 4917 in AIR's CATRADER software (Version 14.0).

The event described in the Global Industry Insured Loss Scenarios around the 1% Exceedance Probability, Loss Scenario 2section corresponds to aggregate year 9033 in AIR's CATRADER software (Version 14.0).

The event described in the Global Industry Insured Loss Scenarios around the 1% Exceedance Probability, Loss Scenario 3 section corresponds to aggregate year 2278 in AIR's CATRADER software (Version 14.0).

The event described in the Global Industry Insured Loss Scenario around the 0.4% Exceedance Probability section corresponds to aggregate year 3886 in AIR's CATRADER software (Version 14.0).

Appendix 4: How-to-Guide: Global EP Curve Generation with Industry Exposure Index Values

This guide assumes a working installation of CATRADER.

1. Open CATRADER and sign in. Create a new company called "Global Insured Exposures"
2. Log in to www.air-worldwide.com and download AIR's UNICEDE take up rates.
3. Open the company "Global Insured Exposures" and import the UNICEDE/2 take up rate files in the Combined CRESTA and the Combined Non-CRESTA directories.

4. Switch to the Programs tab and create a new ground up program called "No Index Countries"
5. Open the program and set the exposure box to "Use Specified Mkt Shrs"
6. Open the "Applies to Area" box and select all the countries except for the 18 countries that have Industry Exposure Index values and title this area "Non-Index Countries". For a complete list of the countries that have an Exposure Index, see [link to AIR Website].
7. Switch to the analysis Options tab and select all the perils except terrorism and MPCI.
8. Save and close this program.
9. For each of the 18 countries that have an Industry Exposure Index value:
    a. Switch to the Programs tab and create a new ground up program called "[COUNTRY] with Index Factor" where [COUNTRY] is the name of the selected country
    b. Open the program and set the exposure box to "Use Specified Mkt Shrs"
    c. Open the "Applies to Area" box, deselect the U.S. and select [COUNTRY]. Title this area "[COUNTRY]"
    d. Switch to the program Options tab and select all the perils except terrorism and MPCI.
    e. Enter the Industry Exposure Index value in the Loss Modification Factor box on the Options tab.
    f. Save and close this program
10. Open the Analysis Screen and set the Programs selector to "All Programs".
11. Set the "As of Date" to "All" and click "OK"
12. Ensure all the perils (except Terrorism and MPCI[8]) are selected and click the "Play" button to begin your analysis.
13. Analyze using the World All Perils 10K event set.

[8] While these instructions did not include MPCI, the loss aggregate loss figures referenced earlier in this document do include losses from the U.S. MPCI based on the latest available industry gross and net premiums. For assistance in including an MPCI program in your analyses, please contact your AIR Worldwide representative.

About AIR Worldwide Corporation

AIR Worldwide (AIR) is the scientific leader and most respected provider of risk modeling software and consulting services. AIR founded the catastrophe modeling industry in 1987 and today models the risk from natural catastrophes and terrorism in more than 90 countries. More than 400 insurance, reinsurance, financial, corporate, and government clients rely on AIR software and services for catastrophe risk management, insurance-linked securities, detailed site-specific wind and seismic engineering analyses, and agricultural risk management. AIR is a member of the Verisk Insurance Solutions group at Verisk Analytics (Nasdaq:VRSK) and is headquartered in Boston with additional offices in North America, Europe, and Asia. For more information, please visit www.air-worldwide.com.

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Authors: Bill Churney, Senior Vice President

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