Weather, Climate & Catastrophe Insight

2018 Annual Report

Aon
Empower Results®

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Executive Summary

2018: Elevated, Yet Manageable Catastrophe Loss Year

Insurance industry in position to handle high volume of claims payouts

USD 225 billion

Economic cost of natural disasters in 2018

USD 90 billion

Insured cost of natural disasters in 2018 – 4th costliest year on record

USD 215 billion

Economic cost of weather disasters in 2018

USD 89 billion

Insured cost of weather disasters in 2018 – 4th costliest year on record

155 MPH

Landfall **wind speed** of Hurricane Michael in Florida; Fourth strongest U.S. Mainland landfall on record

USD 653 billion

2017 & 2018: Costliest back-to-back years for **weather disasters** on record

42 billion-dollar natural disasters in 2018

USD 15 billion

Combined insured losses from Japan typhoon, flood, and earthquake events

USD 237 billion

2017 & 2018: Costliest back-to-back years for **public and private insurers** on record

USD 595 billion

Amount of available **global reinsurance capital**, making the industry well-equipped to handle consecutive high-cost natural catastrophe years

Fourth warmest year

on record dating to 1880 for combined **land** and **ocean temperatures**

394

Individual events

64%

of 2018 **global insured losses** incurred in the United States

35.93 (912.6 mm):

Maximum rainfall total from Hurricane Florence in North Carolina

USD2.1 billion

Insured cost from Windstorm Friederike; **Fifth-costliest European windstorm** of the 21st Century

1.82 million

Acres burned from wildfires in California; Highest on record in the state

Along with this report, we continue to welcome users to access current and historical natural catastrophe data and event analysis on Impact Forecasting's Catastrophe Insight website: **http://catastropheinsight.aon.com**

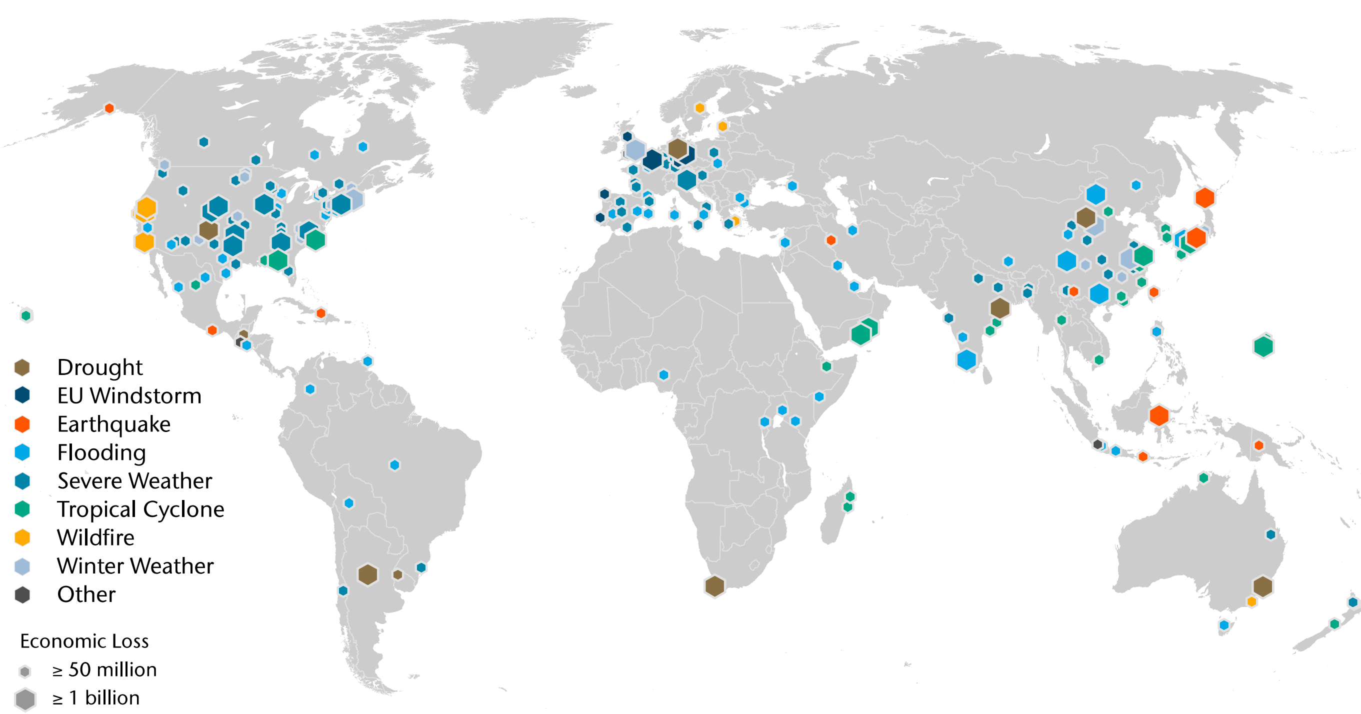
2018 Natural Disaster Events & Loss Trends

Global Economic Losses

Exhibit 1: Top 10 Global Economic Loss Events

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
October 10-12	Hurricane Michael	United States	32	17.0 billion	10.0 billion
September 13-18	Hurricane Florence	United States	53	15.0 billion	5.3 billion
November	Camp Fire	United States	88	15.0 billion	12.0 billion
September 4-5	Typhoon Jebi	Japan	17	13.0 billion	8.5 billion
July 2-8	Flooding	Japan	246	10.0 billion	2.7 billion
Spring & Summer	Drought	Central & Northern Europe	N/A	9.0 billion	0.3 billion
September 10-18	Typhoon Mangkhut	Oceania, East Asia	161	6.0 billion	1.3 billion
July – September	Flooding	China	89	5.8 billion	0.4 billion
November	Woolsey Fire	United States	3	5.8 billion	4.5 billion
August 16-19	Tropical Storm Rumbia	China	53	5.4 billion	0.3 billion
			All Other Events	123 billion	45 billion
			Totals	**225 billion[1]**	**90 billion[1,2]**

Exhibit 2: Significant 2018 Economic Loss Events[3]



[1] Subject to change as loss estimates are further developed
[2] Includes losses sustained by private insurers and government-sponsored programs
[3] Based on events that incurred economic loss greater than USD50 million. Position of an event is determined by the most affected administrative unit or epicenter

Economic losses from natural disasters in 2018 were significantly diminished from the major losses incurred in 2017. However, the USD225 billion total marked the third consecutive year of catastrophe losses surpassing the USD200 billion threshold and was the 10th time since 2000. In terms of economic losses resulting solely from weather disasters – which are defined as events caused by atmospheric-driven scenarios – the global total was USD215 billion. This was a notable reduction from the record-setting tally set in 2017 at USD438 billion but was the sixth-highest total for weather disasters since 1980.

The biggest driver for catastrophes in 2018 was the tropical cyclone peril following several significant landfalling storms, including Hurricane Michael and Hurricane Florence (United States), Typhoon Jebi and Typhoon Trami (Japan), Typhoon Mangkhut (Asia), and Typhoon Rumbia (China). Each of those storms minimally caused at least USD4 billion in damage.

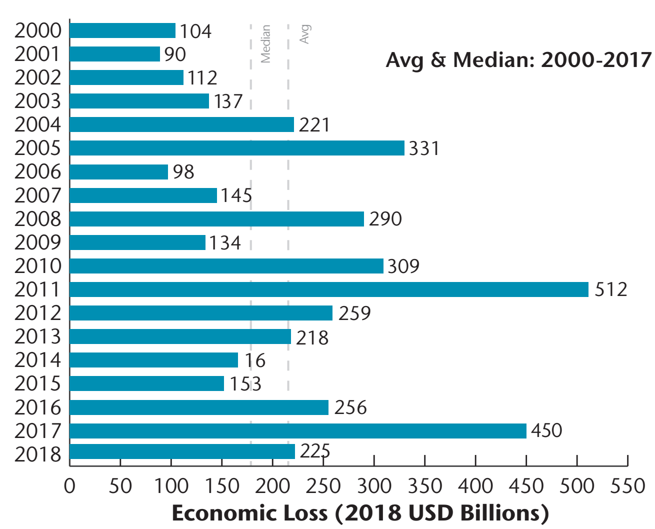
Additional major events during the year included the deadliest and most destructive wildfire ever recorded in California. This is the second year in a row that California set a new record for wildfires. October's Camp Fire destroyed 18,804 structures alone, including most of the city of Paradise. Total economic costs were estimated to approach USD15 billion. In Japan, torrential rains during the month of July led to catastrophic flooding across much of the country with total damage nearing USD10 billion. Another multi-billion-dollar flood occurred in India's state of Kerala during the seasonal summer monsoon months. Much of Northern and Central Europe endured prolonged summer drought conditions as aggregate costs, mostly to agriculture, which tallied to near USD9.0 billion. Multi-billion-dollar drought events also impacted the United States, Argentina, and India. The costliest stretch of severe weather impacted Italy and Austria in late October and early November, as total economic damage was anticipated to reach USD5.0 billion.

Below is a comparison of how 2018 natural catastrophe losses compared to short- and long-term averages and median values.

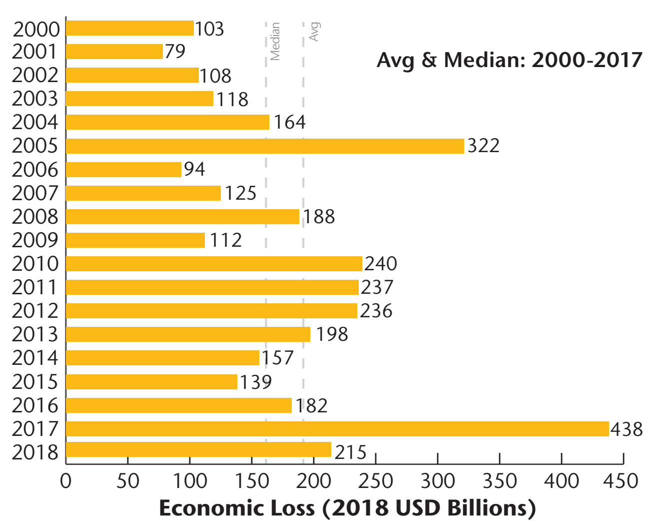
Period All Events	Average (USD billion)	Median (USD billion)
1980-2017	169 (+33%)	137 (+64%)
2000-2017	222 (+1%)	192 (+17%)
2008-2018	275 (-18%)	258 (-13%)

Period Weather Only	Average (USD billion)	Median (USD billion)
1980-2017	135 (+59%)	115 (+86%)
2000-2017	180 (+19%)	160 (+34%)
2008-2018	213 (+0%)	193 (+11%)

Exhibit 3: Global Economic Losses (All Natural Disasters/Left and Weather-Only/Right)



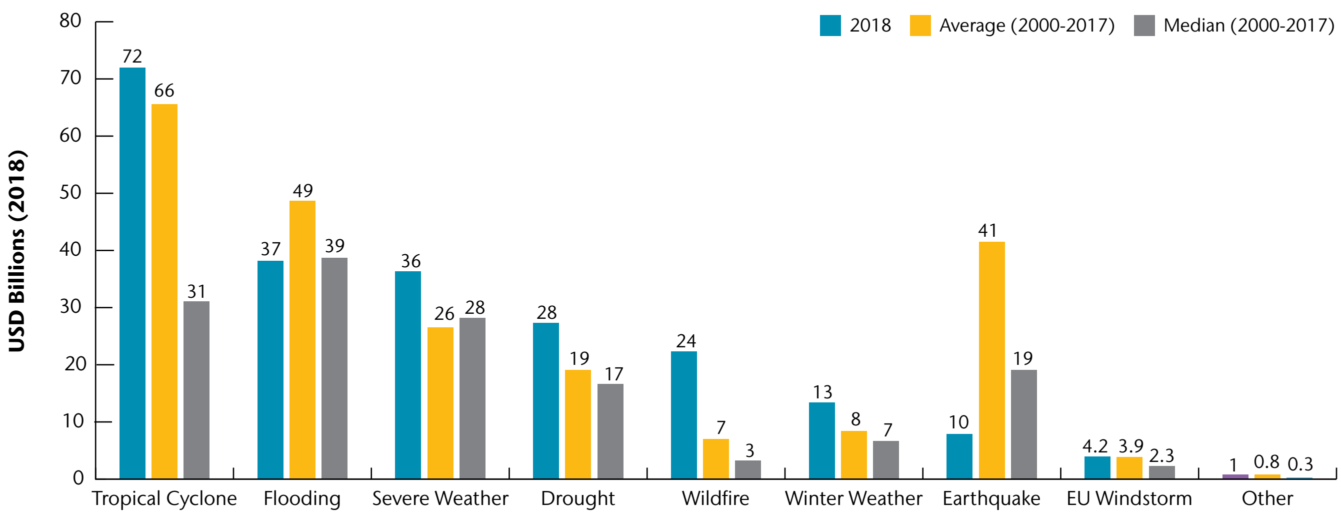
Source: Aon



Source: Aon

At USD72 billion, the tropical cyclone peril was the costliest of 2018. While this marked a substantial drop from the record USD312 billion incurred in 2017, it was still the second highest year for the peril since 2012. Other perils with aggregate damage costs beyond USD25 billion included flooding (USD37 billion), severe weather (USD36 billion), and drought (USD28 billion). For the second consecutive year, wildfire damage exceeded USD20 billion; most of which was incurred in the United States. Exhibit 4 below provides a view of the peril losses in 2018 compared to the recent average and median values from 2000-2017. Since average values can be skewed by outlier years, median analysis is also presented to show a different statistical comparison.

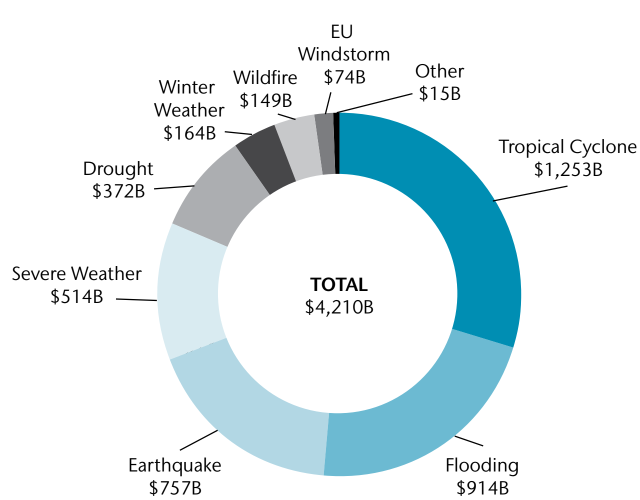
Exhibit 4: Global Economic Losses by Peril



Source: Aon

The costliest global peril around the world since 2000 has been tropical cyclone. This has largely been driven by extreme loss years in 2018, 2017, 2012, 2005, and 2004, which account for nearly USD848 billion of the USD1.25 trillion total alone. The next two perils – flooding and earthquake – are often most frequent and significant in parts of Asia. Perhaps most noteworthy in this analysis is the cost of drought. At USD372 billion, the peril has averaged slightly less than USD20 billion in annual losses in the 21st Century.

Exhibit 5: Aggregate Economic Loss by Peril Since 2000



Source: Aon

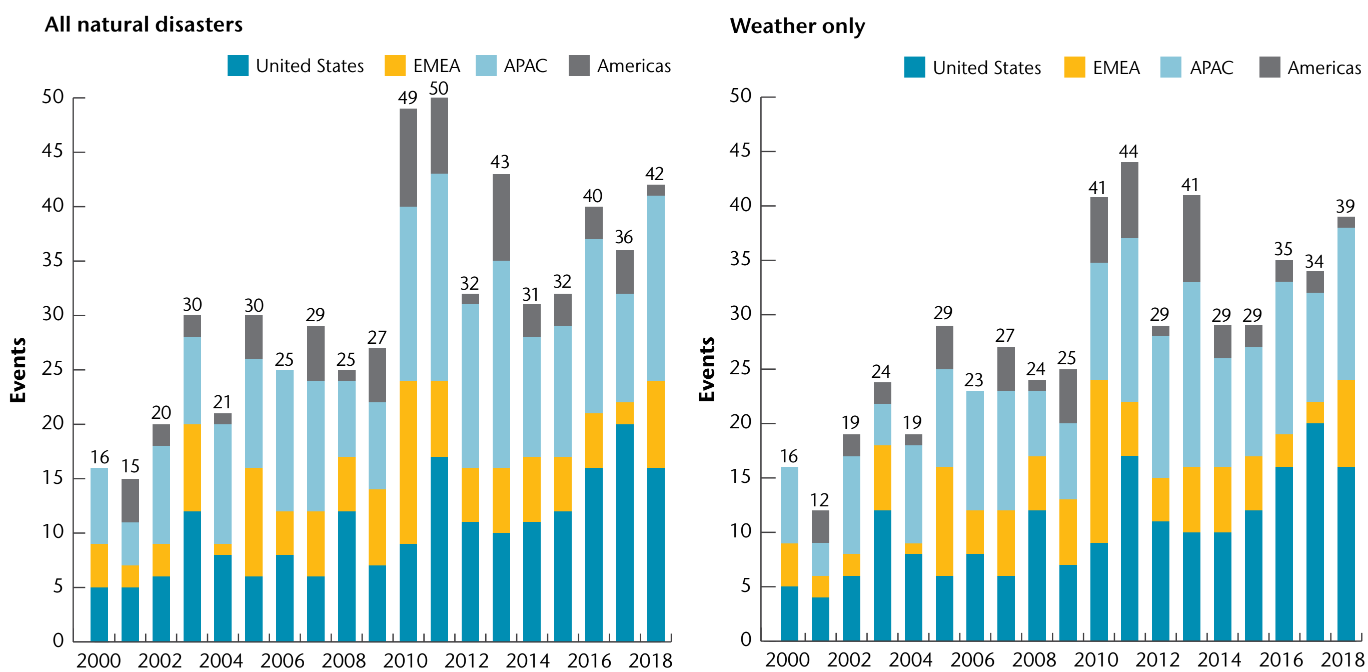
There were 42 individual billion-dollar natural disaster events in 2018, which was above the average of 31 events dating to 2000 and higher than the 36 events that occurred in 2017. Asia Pacific led with 17 events, which was the most in the region since 2013 (19). The United States was second with 16 individual events; slightly less than the 20 in 2017. EMEA had 8 events and the Americas had 1.

In terms of weather-only billion-dollar events, there were 39 individual events. This was higher than the average of 28 since 2000 and notably higher than the 34 events registered in 2017. The United States led with 16 individual events, which was lower than the record 20 in 2017. APAC was second with 14 events and was followed by EMEA (8) and the Americas (1). EMEA registered the highest number of billion-dollar events since 2010.

Please note that if an event causes a billion-dollar loss in multiple regions, this analysis buckets the event based on the region with the highest incurred economic cost. For example, 2017's Hurricane Irma is counted with the United States despite also leaving a multi-billion-dollar cost in the Caribbean.

Also, this analysis treats individual fires as their own billion-dollar events if they surpass the mandated threshold, and not as a singular aggregate (such as how NOAA categorizes fires in the U.S.). The analysis has additionally aggregated seasonal monsoon flood events for some Asian territories.

Exhibit 6: Global Billion-Dollar Economic Loss Events



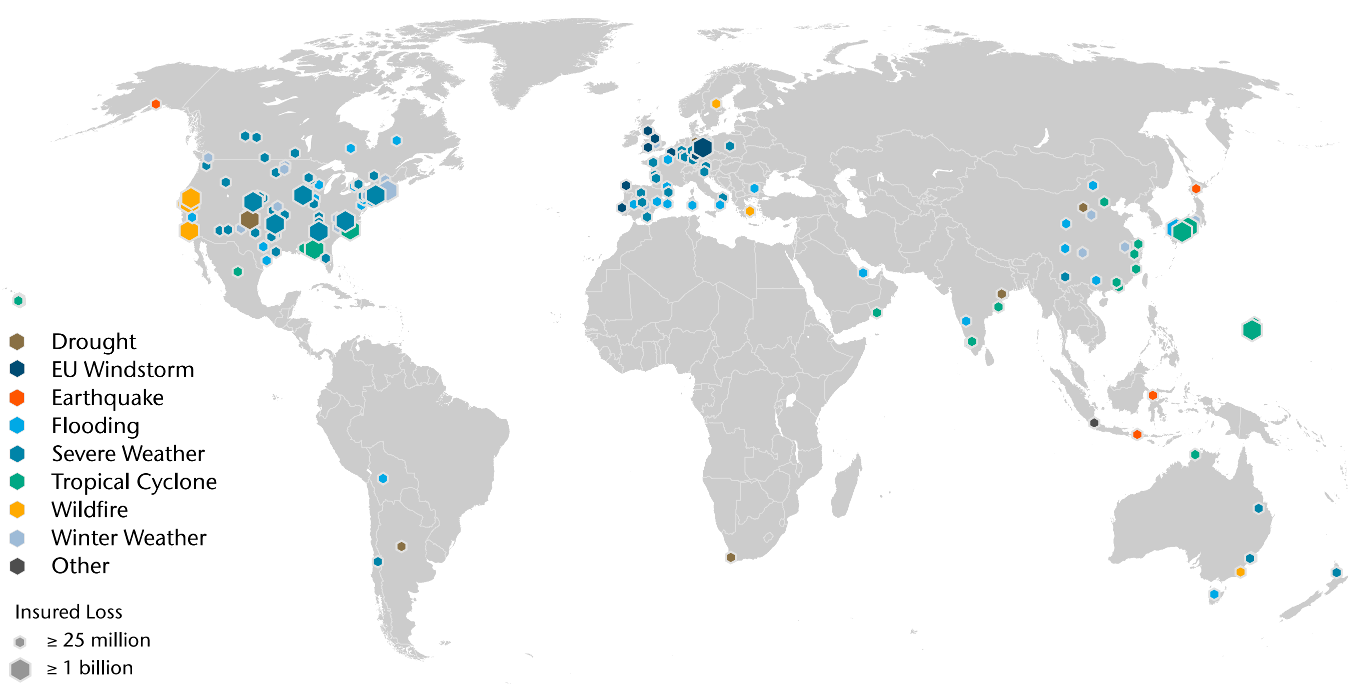
Note: Exhibit 6 includes events which reached the billion-dollar-plus (USD) threshold after being adjusted for inflation based on the 2018 U.S. Consumer Price Index.
Source: Aon

Global Insured Losses

Exhibit 7: Top 10 Global Insured Loss Events

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
November	Camp Fire	United States	88	15.0 billion	12.0 billion
October 10-12	Hurricane Michael	United States	32	17.0 billion	10.0 billion
September 4-5	Typhoon Jebi	Japan	17	13.0 billion	8.5 billion
September 13-18	Hurricane Florence	United States	53	15.0 billion	5.3 billion
November	Woolsey Fire	United States	3	5.8 billion	4.5 billion
July 2-8	Flooding	Japan	246	10.0 billion	2.6 billion
Sep 28 – Oct 1	Typhoon Trami	Japan	4	4.5 billion	2.6 billion
January 18	Windstorm Friederike	Western & Central Europe	13	2.5 billion	2.1 billion
Yearlong	Drought	United States	N/A	3.2 billion	1.8 billion
June 17-21	Colorado Hailstorm	United States	3	2.3 billion	1.8 billion
			All Other Events	136 billion	39 billion
			Totals	**225 billion[1]**	**90 billion[1,2]**

Exhibit 8: Significant 2018 Insured Loss Events[3]



[1] Subject to change as loss estimates are further developed
[2] Includes losses sustained by private insurers and government-sponsored programs
[3] Based on events that incurred insured loss greater than USD25 million. Position of an event is determined by the most affected administrative unit or epicenter

Insured losses from natural disasters in 2018 were much less than what was paid by the industry in 2017. However, the USD90 billion total marked the fourth-costliest year on record for public and private insurance entities based on actual insured totals trended to today's dollars. 2018's total only trailed 2017 (USD147 billion), 2011 (USD148 billion), and 2005 (USD135 billion). In terms of insured losses spawned solely from weather disasters, the global total was USD88 billion. This was a notable reduction from the record-setting tally set in 2017 (USD146 billion) but was the fourth-highest total for weather disasters since 1980.

The protection gap, which is the portion of economic losses not covered by insurance, in 2018 was at its lowest level since 2005. The 40 percent of catastrophe losses covered by public and private entities was on par with the 40 percent in 2005. Both 2005 and 2018 were years in which many of the biggest natural disaster events occurred in the United States, where insurance penetration is higher than in other parts of the world.

The most impactful driver for catastrophes in 2018 was the tropical cyclone peril following several significant landfalling storms. As previously noted, the largest cyclone events included Hurricane Michael, Hurricane Florence, Typhoon Jebi, Typhoon Trami, and Typhoon Mangkhut, which combined cost insurers nearly USD28 billion.

The costliest individual insured loss, however, was Northern California's Camp Fire. That blaze was expected to cost insurers more than USD12 billion. This is the first time in the modern record that a wildfire has been the most expensive industry event in a year. Two other California wildfires – the Woolsey Fire and the Carr Fire – also cost the industry billions of dollars. Other major insured loss events included Windstorm Friederike in Western and Central Europe (USD2.1 billion), a series of significant hail and straight-line wind events across the United States (highlighted by a June Colorado hail event that led to USD1.8 billion in payouts), and the Japan floods in July (USD2.7 billion).

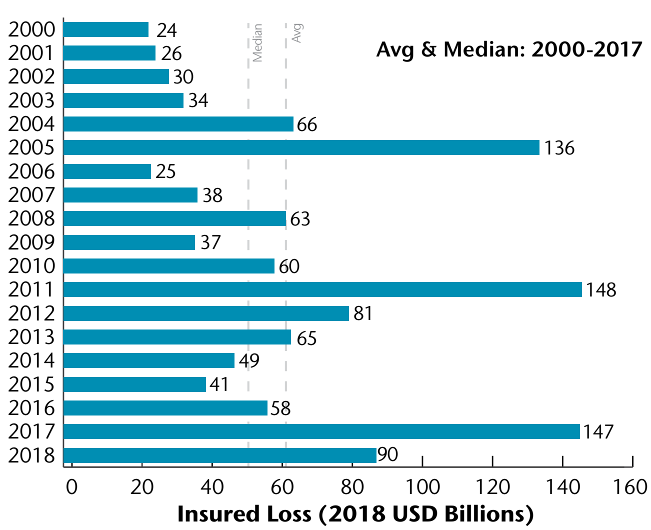
To read more regarding available re/insurance industry capital and the health of the market, please refer to Aon's Reinsurance Market Outlook.

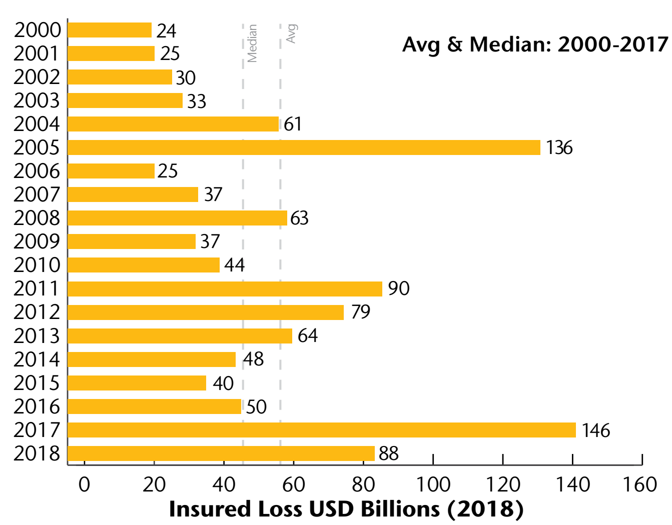
Below is a comparison of how 2018 natural catastrophe losses compared to short- and long-term averages and median values.

Period All Events	Average (USD billion)	Median (USD billion)
1980-2017	41 (+120%)	34 (+165%)
2000-2017	63 (+43%)	53 (+70%)
2008-2018	75 (+20%)	62 (+45%)

Period Weather Only	Average (USD billion)	Median (USD billion)
1980-2017	37 (+138%)	29 (+203%)
2000-2017	57 (+54%)	46 (+91%)
2008-2018	66 (+33%)	56 (+57%)

Exhibit 9: Global Insured Losses (All Natural Disasters/Left and Weather-Only/Right)

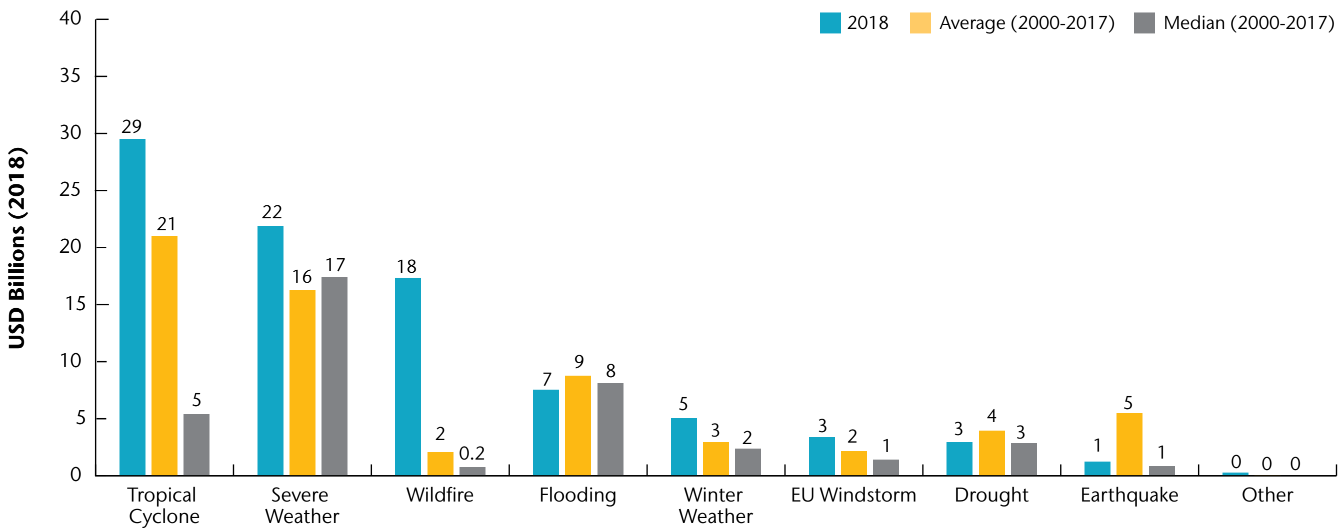




Source: Aon

The costliest peril for public and private insurance entities in 2018 was tropical cyclone. The USD30 billion in payouts were largely attributed to four events: Michael, Jebi, Florence, and Trami. Despite being the lowest year since 2015, the severe weather peril was the second-costliest. Much of those losses occurred in the United States. For the second consecutive year, wildfire losses were substantially higher than historical norms as the aggregate tally topped USD18 billion. Winter weather-related losses were at its highest levels since 2014 for the industry.

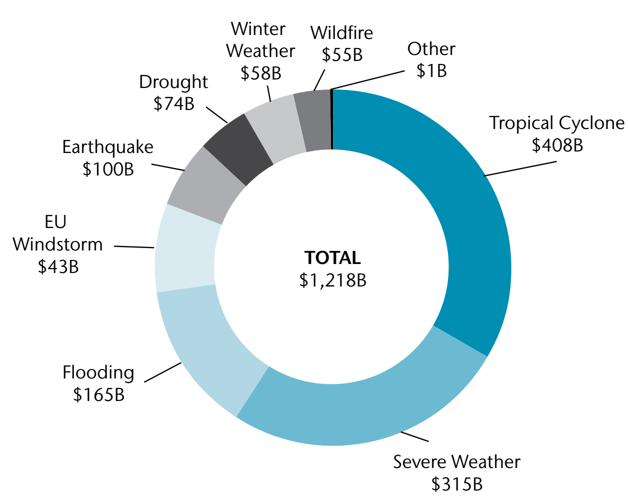
Exhibit 10: Global Insured Losses by Peril



Source: Aon

The costliest peril for insurers in the 21st Century remains tropical cyclone. These losses are typically driven by the frequency, intensity, and location of hurricane landfalls in the Atlantic Ocean Basin. Aggregated tropical cyclone costs for the industry in 2017 and 2018 accounted for 30 percent of the last 19 years' worth of payouts for the peril, and 10 percent of all payouts for the industry regardless of peril. An increasingly costly peril in the United States and Europe has been severe weather with payouts attributed to hail damage to property and agriculture representing a majority of thunderstorm-related impacts.

Exhibit 11: Aggregate Insured Loss by Peril Since 2000

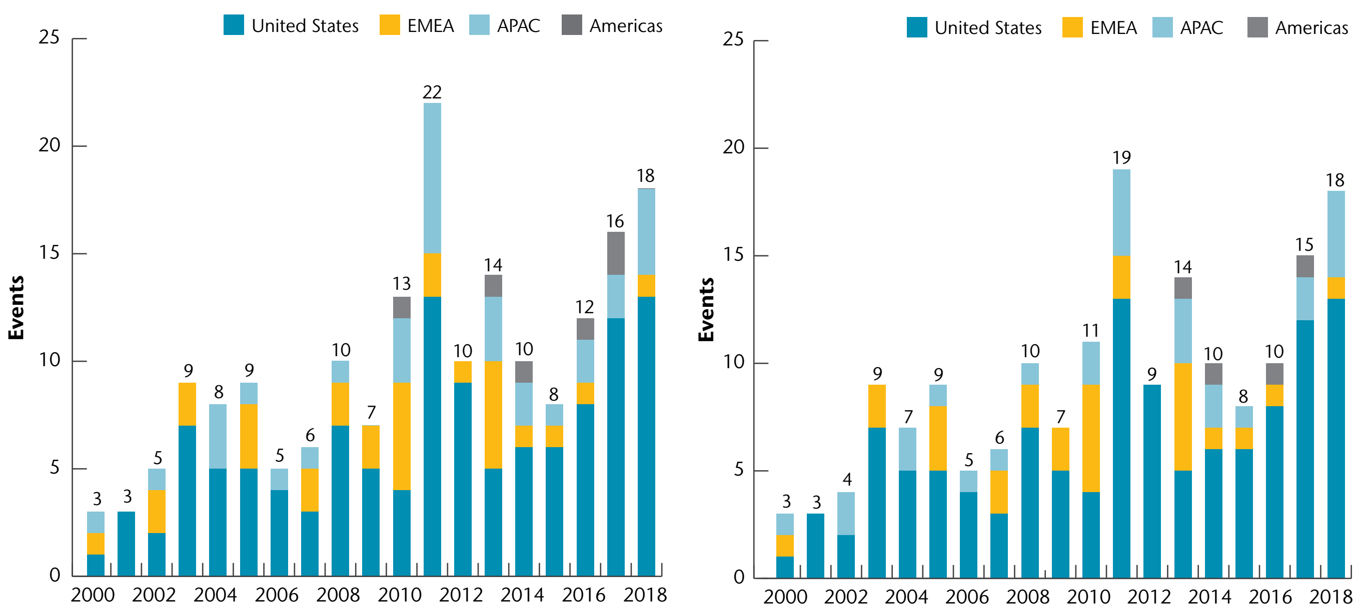


There were 18 individual billion-dollar natural disaster events in 2018, which was well above the average of 10 dating to 2000 and higher than the 16 events that occurred in 2017. The majority of these events were incurred in the United States (13), which matched 2011 as having the highest number of billion-dollar industry events on record. APAC was second with 4 events, of which three occurred in Japan. The only other such global event occurred in EMEA.

For the first time since 2015, every billion-dollar industry event in 2018 was weather-related as there were no earthquake events that resulted in more than USD1 billion in insured losses.

Please note that if an event causes a billion-dollar loss in multiple regions, this analysis buckets the event based on the region with the highest incurred economic cost. For example, 2017's Hurricane Irma is counted with the United States despite also leaving a multi-billion-dollar cost in the Caribbean.

Exhibit 12: Global Billion-Dollar Insured Loss Events



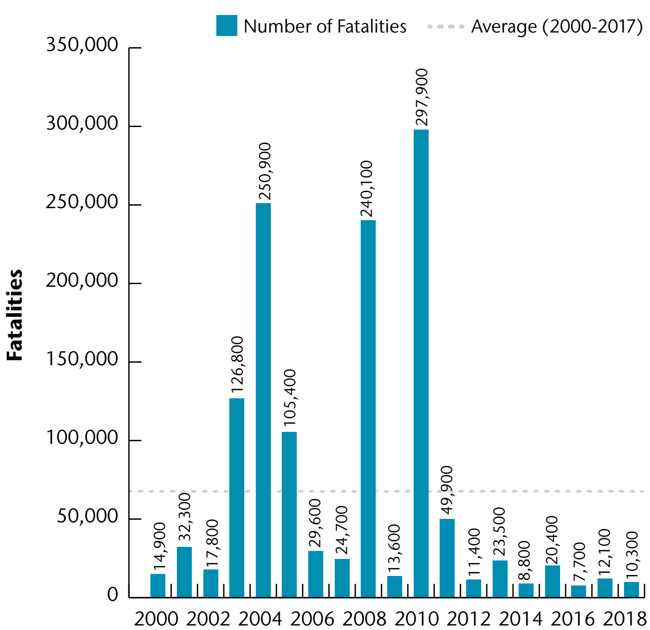
Note: Exhibit 12 includes events which reached the billion-dollar-plus (USD) threshold after being adjusted for inflation based on the 2018 U.S. Consumer Price Index.
Source: Aon

Global Fatalities

Exhibit 13: Top 10 Human Fatality Events

Date(s)	Event	Location	Deaths	Economic Loss (USD)
September 28	Earthquake & Tsunami	Indonesia	2,256	1.5 billion
June - August	Monsoonal Flooding	India	1,424	5.1 billion
August 5	Lombok Earthquake	Indonesia	560	790 million
December 22	Sunda Strait Tsunami	Indonesia	437	250 million
July 2-8	Flooding	Japan	246	10.0 billion
March - May	Flooding	Kenya	226	350 million
June 3-6	Volcan de Fuego	Guatemala	190	220 million
July 17-24	Tropical Storm Son-Tinh	Vietnam, Laos, Philippines, China	170	255 million
September 10-18	Typhoon Mangkhut	Oceania, East Asia	161	6.0 billion
February 26	Earthquake	Papua New Guinea	160	190 million
		All Other Events	~4,500	200 billion
		Totals	**~10,300**	**225 billion**

Exhibit 14: Global Human Fatalities



Source: Aon

More than 10,000 people sadly lost their lives to natural disasters in 2018.

The number of fatalities however did not exceed long-term averages for the eighth consecutive year and reached approximately 10,300. 2018 ranks among the 12 years with the lowest disaster-related fatality totals since 1950.

Approximately 79 percent of fatalities occurred in the Asia Pacific region. This correlates with the fact that seven out of the ten deadliest disasters of 2018 occurred in Asia, including the catastrophic earthquake and tsunami in Indonesia's Sulawesi Island ranking first. Indonesia in particular experienced three of the ten deadliest natural disasters of 2018.

Floods generally were responsible for approximately 36 percent of worldwide fatalities, followed by the earthquake peril, which resulted in 31 percent of deaths.

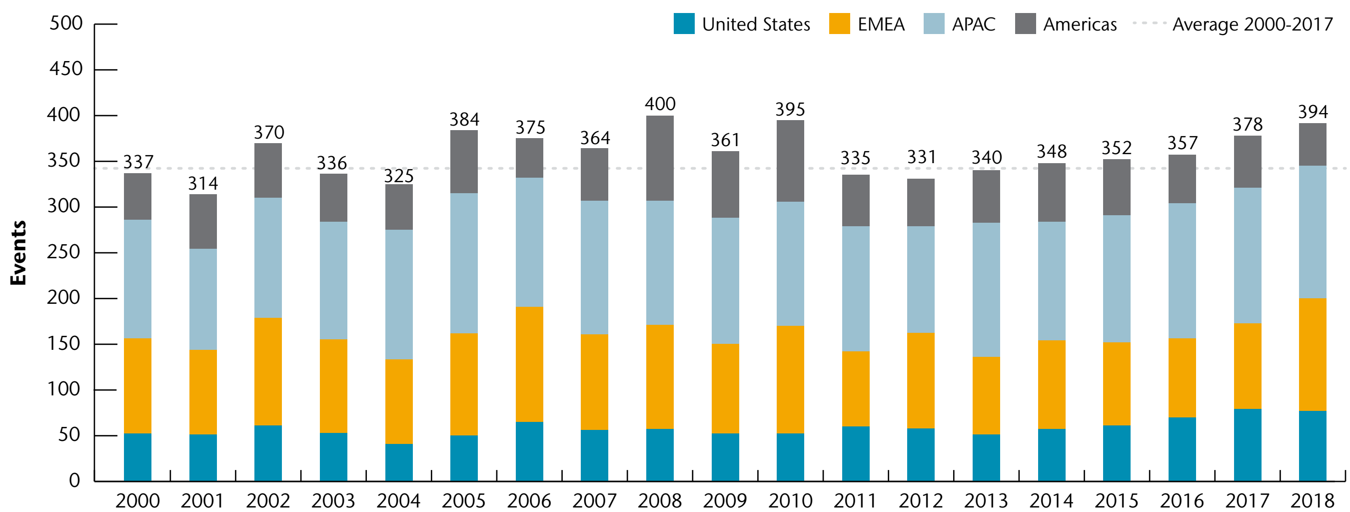
Natural Disasters Defined & Total Events

An event must meet at least one of the following criteria to be classified as a natural disaster:

- Economic Loss: USD50 million
- Insured Loss: USD25 million
- Fatalities: 10
- Injured: 50
- Homes and Structures Damaged or Filed Claims: 2,000

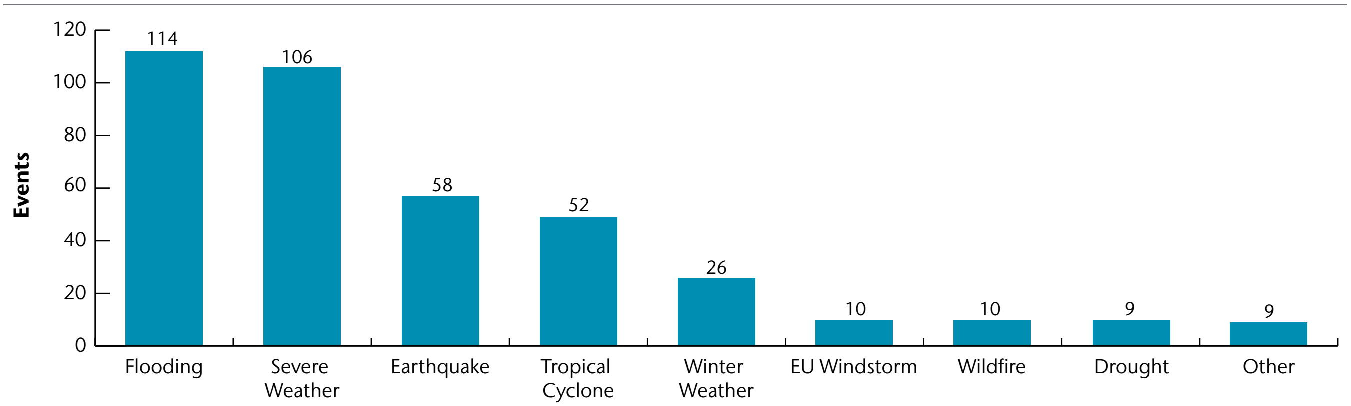
Based on the noted criteria above, there were at least 394 individual natural disaster events in 2018, which was slightly above the average (374) and median (369) since 2000. As typically anticipated, the most number of disaster events occurred during the second (111) and third (116) quarters. APAC incurred the highest number of events, which is expected given Asia's expansive landmass and susceptibility of natural disaster events. However, EMEA and the United States were the only regions that recorded an above average and median number of events.

Exhibit 15: Total Natural Disaster Events



Source: Aon

Exhibit 16: Total Natural Disaster Events by Peril in 2018



Source: Aon

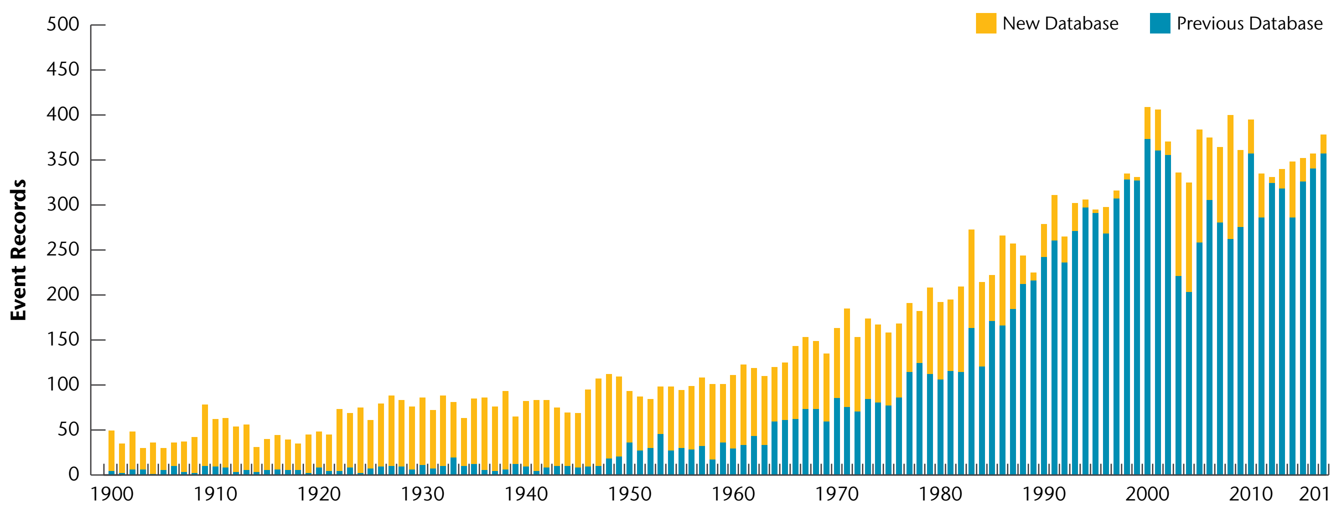
The Data Reanalysis Project

Overview

Debuting in this report is a brand new historical dataset from Impact Forecasting's Catastrophe Insight team. This data is part of an ongoing multi-year reanalysis project that has resulted in a significant expansion of our natural disaster loss database from 12,500 event entries to more than 25,000. To be considered an "event", there is a defined set of criteria which must be met (criteria is provided earlier in this document). Extensive research through various public records via governmental agencies, academic journals, archived newspaper accounts, and more provided a strong foundation to expand the dataset, which now allows an opportunity to conduct annual analysis for years earlier and deeper into the 20th century.

A main focus of the project has been to fill in numerous data gaps for events across parts of Asia Pacific, Africa, and Latin America. This has led to mixed results due to the challenge of finding event data in several countries, but there is now a much broader dataset than previously collected. Many emerging or developing territories have only recently begun in recent years or decades to collect data and make it available to the public, which has often made annual aggregate global loss analysis for years prior to 1980 a difficult task. The reanalysis has had success, with the inclusion of more than 5,150 new global data records from 1900 to 1979. This is an increase of 244 percent.

Exhibit 17: Old vs New Event Entries



Source: Aon

Data quality is among the most important, yet challenging aspects to any type of historical loss analysis. The process of ensuring data quality requires significant research, data mining, cross-checking, and cleaning before any analysis can begin. This is crucial when seeking to minimize uncertainties and provide a robust view of catastrophe losses in any given year. Such a process has been challenging due to individual countries having varying methods and distribution channels of event data collection.

When compiling vast datasets for natural catastrophe events, there are many different specific types of data which prove invaluable to strengthening the understanding and potential determination of any emerging trends. Some of these data types include meteorological or climatological reports, human casualties, physical property or vehicle damage counts, infrastructure and agricultural asset disruption, insurance claims, and business interruption to public and private entities.

To provide further clarity on what is included in an economic loss, we only capture direct event impacts. This combines physical damage to property, infrastructure, and agriculture, net loss direct business interruption, and any mitigation or restoration costs for the event. This does not include secondary or tertiary losses, such as supply chain costs, monetary capital assets, or values tied to loss of life. An insured loss is the portion of the economic loss that is covered by private or public insurance entities.

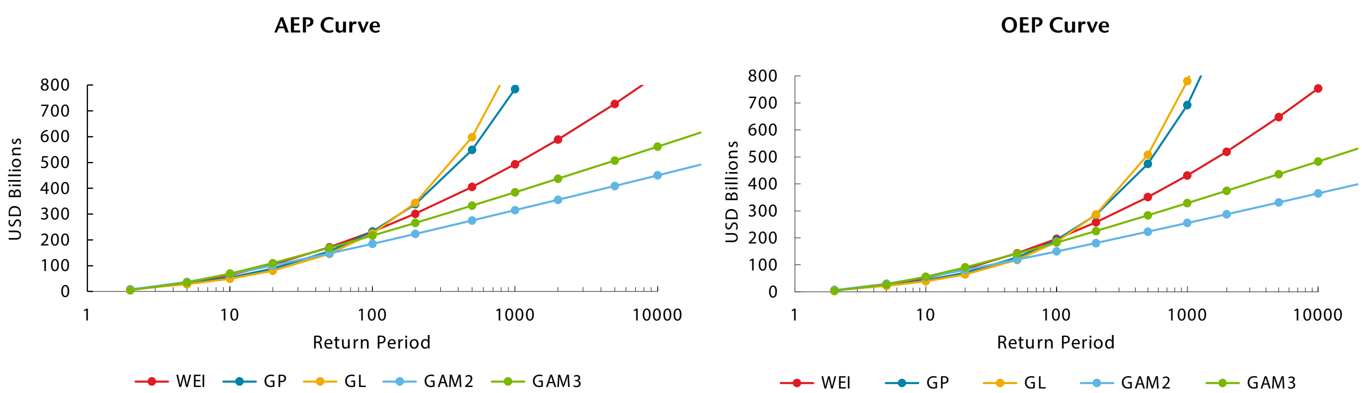
Benefits

A more robust dataset provides numerous benefits including:

1) Increased confidence in loss analysis
2) Opportunity to identify disaster loss trends over a longer time series
3) Greater ability to potentially identify a climate change signal
4) Creation of exceedance probability (EP) curves to provide a non-modeled view of loss chance
5) Offer three unique views of losses: nominal, inflation-adjusted, and normalized

The exhibit below is an example of the type of Exceedance Probability (EP) curves that can be created based on the reanalysis data. The two types of curves – Annual Exceedance Probability (AEP) and Occurrence Exceedance Probability (OEP) – each provide helpful analysis based on the historical data. AEP is simply the probability of total annual combined (aggregated) losses occurring in any given year; while OEP is the probability of individual maximum loss events occurring in any given year.

Exhibit 18: Example Exceedance Probability Curves



Source: Aon

What's New?

The reanalysis project has led to notable changes to aggregate and individual historical loss totals. We now have a new set of baseline numbers from a short-, medium-, and long-term average and median perspective that are higher than before given a more robust dataset. The database was previously based on event aggregate totals. To provide more granularity, each event now also has an individual country-level breakout with further details to allow for even more specific analysis. Many of the largest natural catastrophe events were reviewed to ensure accuracy, and adjustments were made when necessary. We also worked to provide more inclusion of global drought and agricultural sector losses since these events often lead to a significant financial toll.

The concept of loss development, which is also referred to as loss creep, was another contributing factor to some increased loss changes. This is where a clearer picture on loss estimations emerge as more insurance claims information is received and government agencies fully complete direct economic assessments. This was especially true for many events in 2017. Notable revisions occurred for Hurricanes Harvey, Irma, and Maria and the California wildfires. Also, in the case of Hurricane Harvey, the direct economic loss estimate was raised from USD100 billion to USD125 billion, which is also in line with NOAA's official estimate.

Normalization

The reanalysis project has additionally led to the introduction of a normalized economic loss dataset. A normalized insured loss dataset is forthcoming. This is to provide another unique view of historical catastrophe losses. For this process, we implemented slight tweaks to well-established and peer-reviewed methods first introduced by Pielke and Landsea (1998) and Collins and Lowe (2001). To assure an across-the-board and consistent global analysis, we implemented changes in population/exposure and wealth (GDP) on a national level. This is a shift from the U.S.-centric analysis in the previously mentioned literature that had county-level data available. Obtaining county, postal code, or CRESTA level data on a completely global scale is unfortunately not realistically available at this time. We acknowledge that providing national-level normalization is not ideal and lends to greater uncertainty in resultant values.

One challenge to current normalization methods is the incomplete nature of fully accounting for vulnerability. Most peer-reviewed normalization techniques do not entirely capture improvements in building construction and codes nor wholly represent these improvements when hypothesizing historical scenarios in modern time.

Normalization data is a useful piece of analysis when trying to simulate historical event scenarios impacting areas with current levels of population, exposure, and wealth. This is a different type of data analysis from actual incurred nominal loss values (losses at the time of occurrence) and/or inflation-adjusted values (nominal losses trended to today's dollars).

Data Uncertainty

An inevitable challenge in any global natural disaster loss collection is coping with uncertainty in the data. Some of the most obvious contributing factors surround a lack of available records, over- or under-estimation of damage or financial loss, conflicting data records, and an attempt of event loss quantification purely based on the number of impacted structures or vehicles. There are also important regional issues that lend to further uncertainty such as economic variability, currency exchange conversions, and inflation. In Europe, for example, there are notable gaps in data records and availability during the early and middle portions of the 20th century. This is directly tied to World War I and World War II.

Next Steps

The reanalysis database project is an ongoing initiative that will continue to result in newly researched events and evolving historical loss analysis. This is a fluid project with no discernible end. We hope to expand the normalization process and further fill in existing data gaps. An important part of the process will be identifying insured losses based on time-of-date penetration levels and attaching an economic loss value to events where the number of impacted structures is provided.

Our goal with the reanalysis project is to gain more definitive insights into the trends of historical catastrophe losses over time on a nominal, inflation-adjusted, and normalized level. It is already well-established that nominal and inflation-adjusted catastrophe losses are increasing at a statistically significant level. The most intriguing question remains whether an appropriately normalized methodology will show similar rates of growth. As of today, most literature on the subject shows a positive trend, but not yet significant. We also hope that the more robust dataset will allow for the identification and quantification of the impact of climate change.

Peril Focus: Tropical Cyclone

2018 was another very active year for tropical cyclone activity across the globe. While not as financially expensive as the historic year in 2017, storms combined to cause at least USD72 billion in economic damage. This is a significant reduction from the record USD312 billion from the previous year that was primarily driven by hurricanes Harvey, Irma, and Maria. For public and private insurance entities, claims payouts were nearly USD30 billion from the peril. This compares to the nearly USD94 billion incurred in 2017.

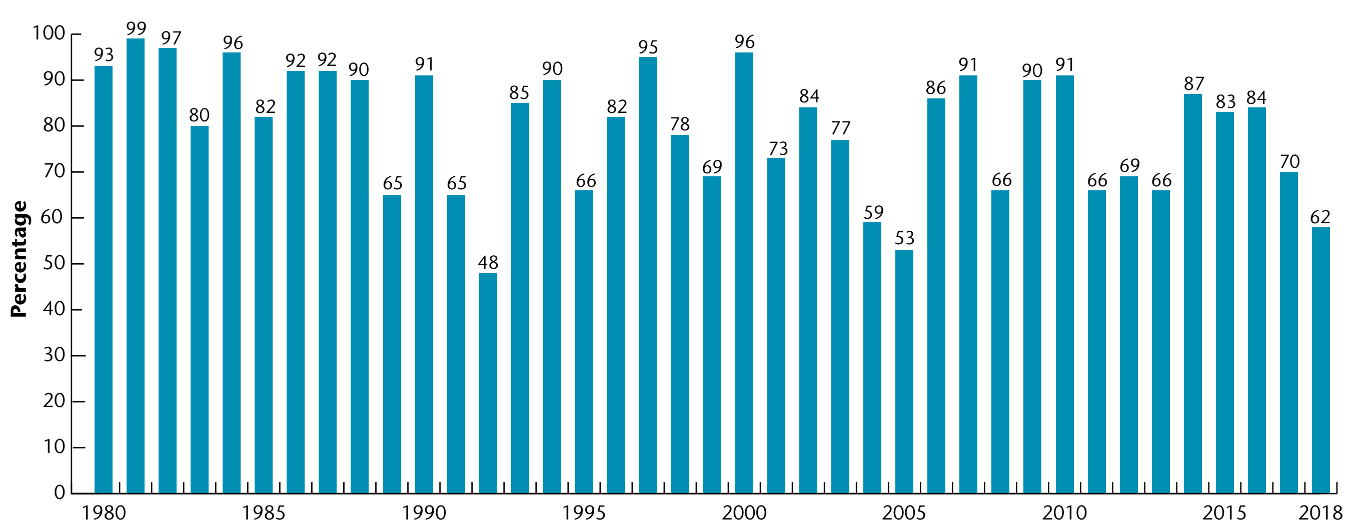
Unlike in 2017, in which most losses and extensive damage was attributed to Atlantic Ocean Basin storms, 2018 was marked by major events that impacted the United States, Japan, China, the Philippines, Guam, and the Northern Mariana Islands.

One of the biggest impacts of the tropical cyclone peril is the continued large protection gap. A protection gap is defined as the portion of the economic loss that is not covered by insurance. Since 1980, the percentage of tropical cyclone-related damage is 31 percent. This means that 69 percent – or USD1.1 trillion – of global storm damage has gone uninsured.

There are several reasons for this large gap with the primary reason being the continued low levels of insurance penetration in landfall-prone areas. This is especially true in parts of Asia and Latin America. As these landfalls occur, while wind or water-related damage can be widespread and significant, a high portion of residents do not have homeowner insurance policies in place to handle the cost of the event's impact. Beyond the lack of insurance, many properties in these developing regions are not often built to withstand the intense nature of hurricane-force winds or built along the coast withoutproper elevation to alleviate potential storm surge inundation.

While the protection gap is often highest in emerging markets for the peril, a large gap can also occur with hurricane events in the United States. Much of the U.S. gap is determinant on the primary source of damage. A typical homeowner's policy does not include flood-related impacts, such as storm surge or inland riverine flooding. For large events in which water is the dominant damage source – such as Harvey (2017) or Florence (2018) – a sizeable portion of the loss is uninsured since many residents and business owners either do not own a National Flood Insurance Program (NFIP) policy or the value of the policy does not cover the total cost of the flood loss. When losses are primarily driven by wind – such as Andrew (1992) or Michael (2018) – the gap is lower.

Exhibit 19: Global Protection Gap for Tropical Cyclones



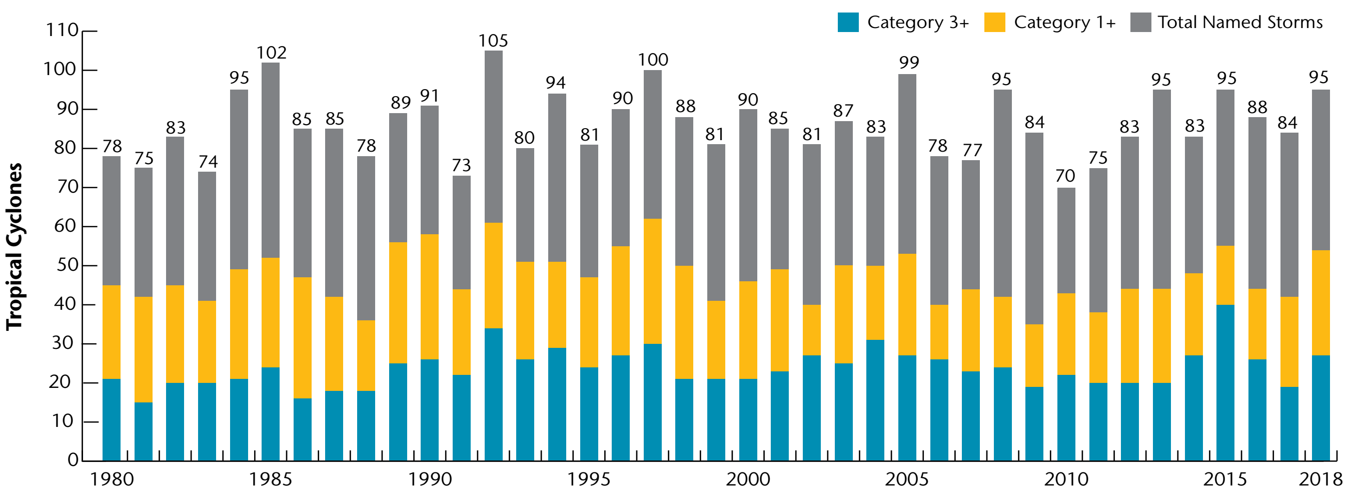
Source: Aon

Global Activity

The overall number of named storms was above average in 2018. While the final numbers are still subject to reanalysis by international tropical cyclone agencies, current numbers indicate there were 95 named storms; higher than the average (1980-2017) of 86 and the most named storms since 2015. There were 54 hurricanes, typhoons, cyclones – storms with sustained, 1-minute average wind speeds of at least 74 mph or 119 kph – which was above the average of 47. Of those 54 events, at least 27 reached “major” status of reaching Category 3 or greater intensity on the Saffir-Simpson Hurricane Wind Scale. This indicates sustained, 1-minute average wind speeds of at least 111 mph or 179 kph. The 27 major storms were above the average of 24.

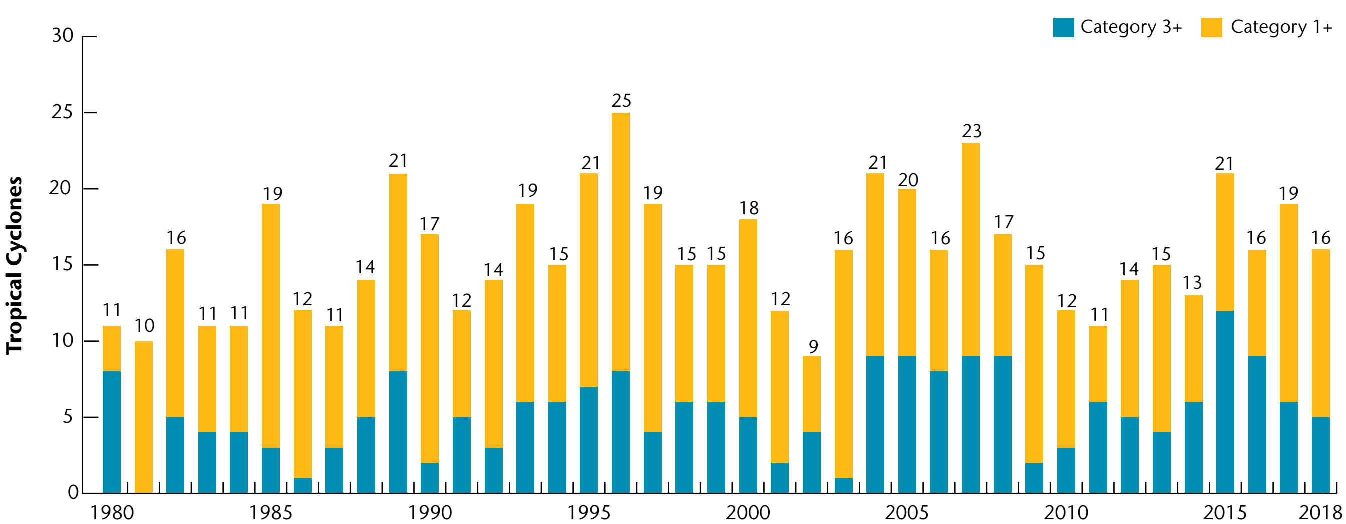
In terms of global landfalls, 16 Category 1 or stronger storms came ashore. Five of those made landfall at Category 3 strength or above. Landfall averages from 1980-2017 include 16 Category 1+ and 5 Category 3+ events. Nearly every tropical cyclone basin – Atlantic, Eastern Pacific, Northwest Pacific, Northern Indian, South Pacific – recorded a Category 3+ landfall during their respective 2018 seasons.

Exhibit 20: Global Tropical Cyclone Activity



Source: Aon

Exhibit 21: Global Tropical Cyclone Landfalls



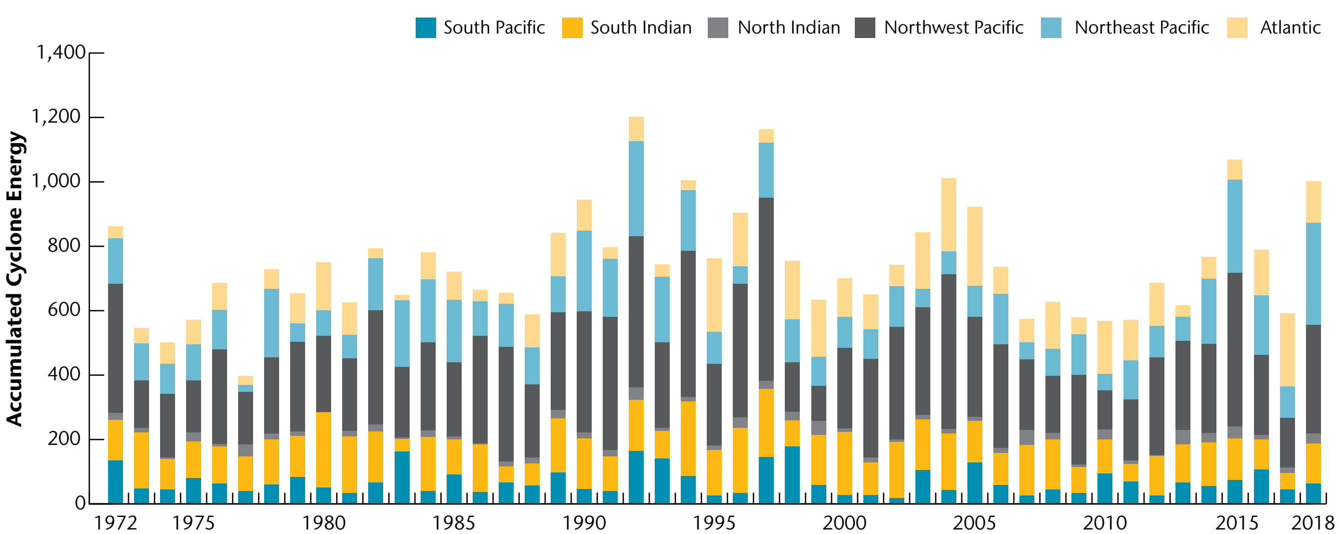
Source: Aon

A different measure used to gauge the activity of individual tropical cyclones and its seasons is Accumulated Cyclone Energy (ACE). ACE for an individual tropical cyclone is calculated by adding together the squares of the (estimated) maximum wind speed for the storm from the time it is named (i.e. maximum wind speeds are 40 mph (65 kph) or higher) for every six-hour period until it dissipates. The total number is then divided by 10,000 to give a more manageable figure. For an entire cyclone season, ACE is calculated by summing the totals for each individual storm. The square of the maximum wind speed is used, as this is proportional to kinetic energy, so by adding the squares of the wind speeds together, a measure of accumulated energy is acquired.

On average, more than one-third of global accumulated cyclone energy is record in the Northwest Pacific Basin. Slightly less than one-fifth is recorded in both the South Indian Ocean and Northeast and Central Pacific Basins. The Atlantic Basin generally contributes 15 percent. The South Pacific Basin on average amounts to slightly less than 10 percent of the global total, while the North Indian Basin accounts for the remaining few percent.

Global ACE in 2018 was 1,002, or 46 percent higher than the recent 10-year average of 687. It was also 30 percent higher than the long-term average from 1980-2017 of 769. Every major tropical cyclone basin in the Northern Hemisphere was above the climatological average in 2018. The Northeast Pacific Ocean Basin set a record for the most ACE since at least 1972 at 316. The record year for ACE was 1992 when a value of 1,203 was recorded.

Exhibit 22: Global Accumulated Cyclone Energy

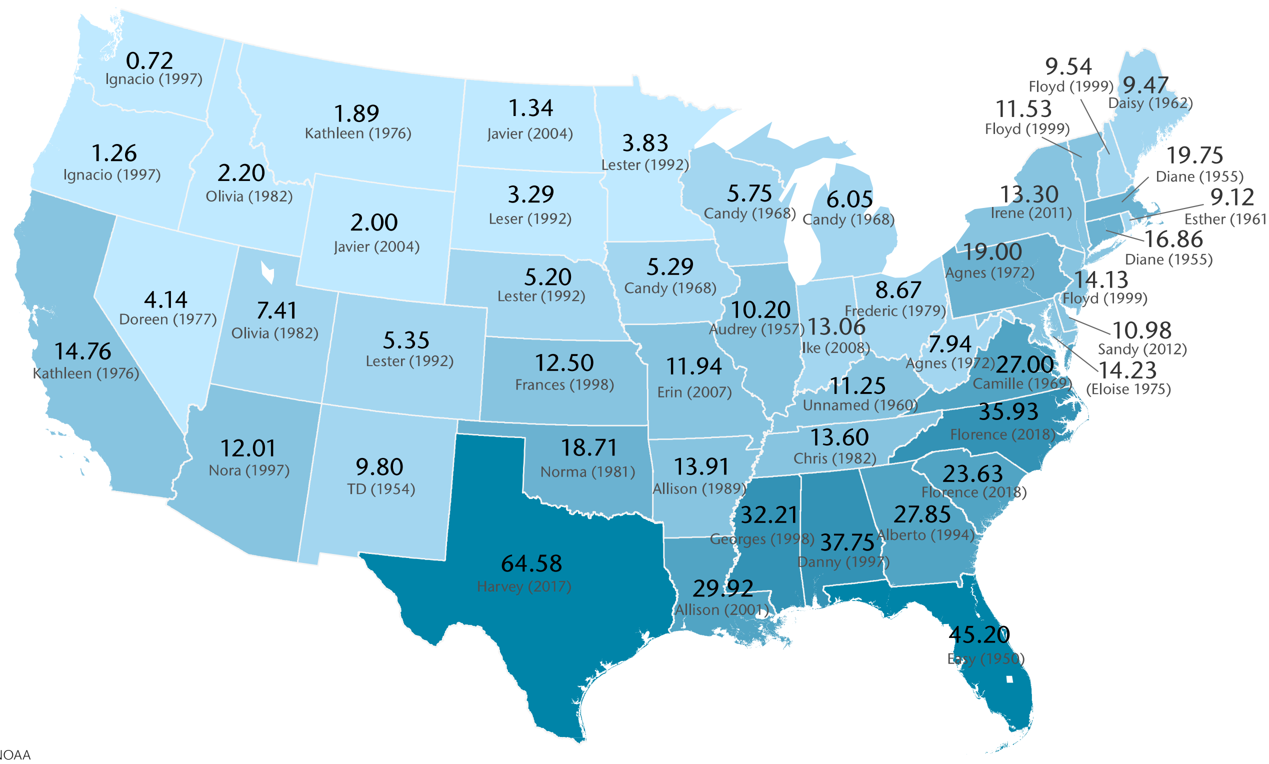


Source: Aon

Atlantic Ocean Basin

There were only two hurricane landfalls during the 2018 Atlantic Hurricane Season, though both occurred in the United States: September's Hurricane Florence and October's Hurricane Michael. Florence came ashore as a Category 1 storm in North Carolina, though it spawned catastrophic inland flood damage across North Carolina, South Carolina, and parts of Virginia. Florence set new tropical cyclone rainfall records in both North and South Carolina. Total economic losses were minimally estimated at USD15 billion, though only one-third of the damage was expected to be covered by insurance due to low take-up of National Flood Insurance Program (NFIP) policies across inland parts of the Carolinas.

Exhibit 23: Maximum Tropical Cyclone Rainfall by State



Source: NOAA

The most substantial tropical cyclone of the year, however, was Hurricane Michael. The storm made landfall near Mexico Beach, Florida at peak intensity with 155 mph (250 kph) winds. It was the strongest hurricane on record to strike the Florida Panhandle, and the third-strongest landfalling hurricane in the United States. Michael's damage was felt well inland beyond the landfall location, with heavy damage to property, infrastructure, and agriculture noted in parts of Florida, Georgia, Alabama, North Carolina, South Carolina, and Virginia.

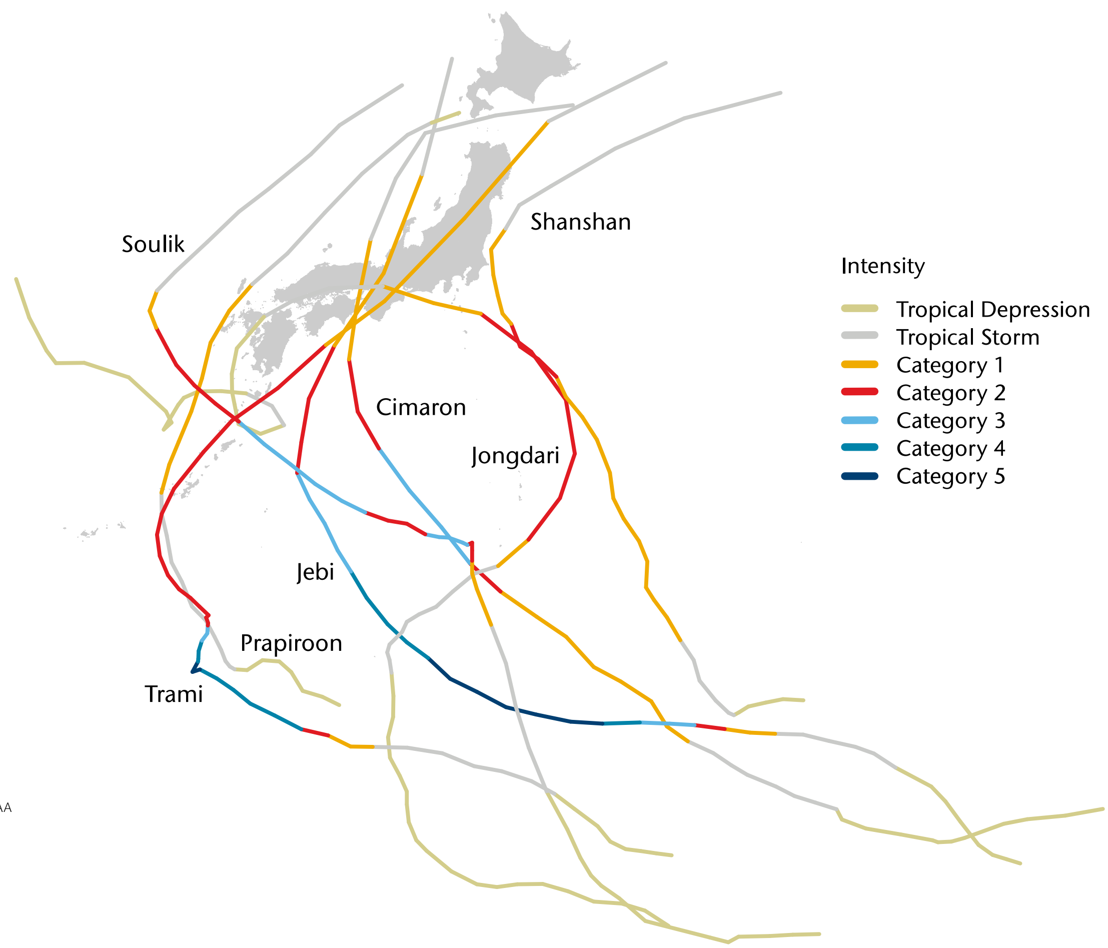
Total economic losses from Michael were minimally estimated at USD17 billion. Public and private industry losses were expected to be at least USD10 billion. The higher insured loss percentage for Michael versus Florence was due to a higher portion of damage being caused by winds. Such damage is typically covered by a standard homeowner's policy.

West Pacific Typhoon Season

After a below-average typhoon season in 2017, the West Pacific produced some of the costliest storms of the year in 2018. There were 29 named storms, of which 14 were typhoons and 7 super typhoons. Super typhoons Kong-rey and Yutu both became Category 5 storms in October and tied for the most intense storms in any basin in 2018. Kong-rey in the West Pacifc and Walaka in the East Pacific reached Category 5 status at the same time, making this the first time since 2005 that two Category 5 cyclones existed simultaneously. While Kong-rey did not make a direct landfall, Yutu struck Tinian with 1-minute sustained wind speeds of 285 kph (180 mph), becoming the strongest storm to ever impact the Northern Mariana Islands.

There were three storms that resulted in insurance payouts in excess of USD1 billion: Typhoons Jebi (USD8.5billion), Trami (USD2.6 billion), and Mangkhut (USD1.3 billion). The deadliest storm of 2018 in West Pacific was Tropical Storm Son-Tinh which affected Vietnam, Laos, China, Philippines in July, and caused 170 deaths. Typhoon Mangkhut killed 161 people across Philippines, China, and Taiwan - a large majority of that being in Philippines where Mangkhut struck as a Category 5 super typhoon.

Exhibit 24: Typhoon Tracks Near Japan in 2018



Source: NOAA

East Pacific Hurricane Season

The East Pacific saw the highest Accumulated Cyclone Energy on record dating back to 1971 and became the fourth-most active season with 23 named storms. A total of 13 named storms reached hurricane intensity, including three that intensified to Category 5 strength.

Hurricane Lane reached Category 5 on August 22 with sustained 1-minute wind speeds of 260 kph (160 mph). While Lane did not strike Hawaii as a hurricane, it brought rainfall of up to 1,321 millimeters (52 inches), becoming the wettest storm on record in Hawaii and the second wettest anywhere in the U.S. after 2017's Hurricane Harvey in Texas. Hurricane Lane caused USD250 million in damage of which USD55 million was covered by insurance.

On October 2, Hurricane Walaka became a Category 5 storm with sustained windspeeds of 260 kph (160 mph) and the second lowest central pressure of any Pacific hurricane (920 hPa) – after Hurricane Ioke of 2006. While Walaka dissipated without any significant impacts, the third Category 5 storm in East Pacific – Hurricane Willa made a Category 3 landfall in Mexico on October 24 and caused USD500 million in losses, becoming the most expensive storm in the basin for the season.

Southern Hemisphere Cyclone Season

In the South PacificOcean, there were six tropical cyclones between January-May as a part of the 2017-2018 season and one in September as a part of 2018-2019 season. The strongest storm was Cyclone Gita which reached 10-minutes maximum sustained wind speeds of 205 kph (125 mph) in February. Cyclone Gita became the costliest storm in Tonga's history after causing damages of USD160 million. Tropical Cyclone Liua formed on September 26, marking the beginning of the 2018-2019 season – the earliest formation of a named storm in any season since the beginning of records in the region.

Eight tropical cyclones formed in the Australian region (South Indian Ocean and South Pacific Ocean between 90°E and 160°E) between January and April as a part of the 2017-2018 season and two between September and December as a part of 2018-2019 season. Cyclone Marcus was the strongest storm that formed in the area, reaching peak wind speeds of 230 kph (145 mph) in March. Marcus weakened to make landfall as a tropical storm in Australia's Northern Territory an caused around USD75 million of economic loss, however only around USD45 million was covered by insurance.

In the Southwest Indian Ocean, eight named storms (6 tropical cyclones) formed in the 2017-2018 season, which began at the end of December 2017 and was largely below average in terms of activity. Cyclone Ava, the first storm of the season, went on to cause 73 fatalities across Madagascar. In the 2018-2019 season, three cyclones formed till date with no significant impacts.

North Indian Cyclone Season

The North Indian basins (Bay of Bengal and Arabian Sea) saw a total of seven cyclonic storms (of which four were cyclones of Category 1 or higher) forming in 2018 – much higher than the average 3-4.

Tropical Storm Sagar formed over the Gulf of Aden in May and was the first named storm of the season. It made landfall in Somalia with 1-minute maximum wind speeds of 95 kph (60 mph) becoming the strongest cyclone ever to strike Somalia and tying with a 1984 storm for the record of the westernmost landfall for the North Indian basin. Sagar caused 79 deaths and USD50 million in damages across Somalia, Yemen and Djibouti.

Cyclone Mekunu formed in the Arabian Sea later in May and became the strongest storm of the season in the North Indian basin, reaching peak 1-minute sustained wind speeds of 185 kph (115 mph). Mekunu killed 31 people across Yemen and Oman and caused over USD1.5 billion in damages. Cyclone Mekunu became the first Category 3 landfall in southwest Oman and triggered insurance payouts of USD400 million in the country.

The region suffered a rare third significant storm in October as Cyclone Luban made landfall in Yemen as a tropical storm and caused around USD1 billion in damages, becoming the most expensive storm for the North Indian basin in 2018.

While Cyclone Luban was active in the Arabian Sea, on the Bay of Bengal side of the North Indian Ocean, Cyclone Titli tracked towards the eastern coast of India – making this the first time that two cyclonic storms have existed simultaneously in the North Indian Basin in the satellite era. Titli struck Andhra Pradesh and Orissa and caused USD920 million in damages. Cyclone Titli became the deadliest storm in the North Indian basin with a death toll reaching at least 85. The other notable storm in the basin was Cyclone Gaja that struck south India in November, killing 63 people and causing economic loss of USD775 million.

Hurricanes of 2018 –
a Tale of Two Landfalls

The Insurance Institute for Business & Home Safety (IBHS)

As devasting forces of nature, 2018's Hurricane Florence in coastal North Carolina and Hurricane Michael in the Florida Panhandle left loss and harm in their wake. They also taught important lessons that can improve our defense against future storms and enhance forecasting prowess.

Florence had an unprecedented landfalling track, which complicated forecasting. Just prior to landfall, Florence slowed, and her winds weakened, but the wide storm pushed an enormous surge on shore and lingered to dump heavy inland rainfall. The result was historic flooding across the entire region and serious wind damage along the immediate coast.

While the nation watched Florence approach for days, it seemed that Michael emerged "out of nowhere". Michael formed near the Yucatan Peninsula and raced across the Gulf of Mexico, strengthening rapidly just before landfall. Michael was a rare event with winds at landfall that exceeded the design level for the area. The damage in Mexico Beach and Panama City illustrates how catastrophic a Category 4 hurricane can be.

Both storms brought punishing wind, wind-driven rain and storm surge, exploiting the weakness inherent in thousands of properties. However, they also offered stark evidence that we can build defensively and narrow the path of damage. Resilient homes – IBHS FORTIFIED homes – in both North Carolina and Florida survived intact. Such resilience involves key decisions:

- Get the roof right
  - Newer roofs fared well in Hurricane Florence and in most areas impacted by Hurricane Michael. IBHS is analyzing asphalt shingle performance following carefully monitored aging in a variety of climate scenarios. Together with our post-hurricane observations, the shingle analysis will lead to a better understanding of vulnerability.
  - Having a sealed roof deck, part of the IBHS FORTIFIED requirements, prevents significant water intrusion if the roof cover is lost, limiting the cascade of further damage.
- Openings and connections are critical
  - Garage doors can be a damage multiplier. Wind passing through a buckling door can increase the pressure inside a house, making it more likely to lose the roof.
  - Tying the pieces of the structure together with strong connections is critical to wind resistance. Well-informed building codes based on the latest science should be adopted and enforced in hurricane prone states.
- Storm surge and flooding
  - The options for getting out of the way of rising water are limited to building higher, building elsewhere, or engineering the flow of the water to go elsewhere. These require difficult choices.

However, resilience is possible. The basic solutions are both simple and science-based. We must shape our homes and in hurricane-prone areas to be resilient against these weather forces.

Resilience is possible. The basic solutions are both simple and science-based. We must shape our homes and in hurricane-prone areas to be resilient against these weather forces.

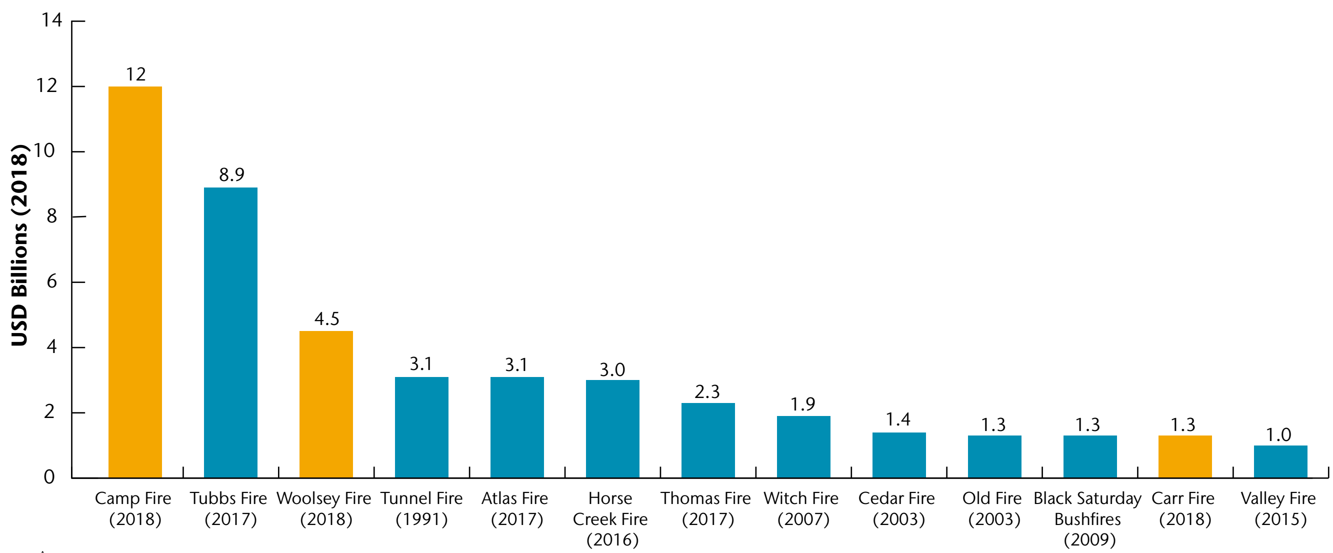
Peril Focus: Wildfire

For the second consecutive year, the wildfire peril had tremendously elevated damage losses and human casualties. Most of the losses were once again driven by catastrophic fire events in the state of California. Total insured losses for the peril, globally, were just shy of USD20 billion – a new record. This was even higher than the USD17 billion incurred in 2017. Overall economic losses were even higher at USD24 billion.

The three most significant fire events of 2018 each occurred in California. November's Camp Fire was the year's costliest industry event at USD12 billion, though it is worth noting that as loss development occurs well into 2019, it is expected that the final total may be even higher. The Camp Fire left most of the city of Paradise in Butte County, CA destroyed as 18,804 homes and other structures were lost. At least 88 fatalities were confirmed. This made the Camp Fire the most destructive and deadliest fire on record in the state. Another multi-billion-dollar fire – the Woolsey Fire – simultaneously burned in Southern California's Ventura and Los Angeles Counties in November. No fewer than 1,643 structures were destroyed, and three people were killed. The third billion-dollar wildfire in California was the late summer Carr Fire. That fire caused an estimated USD1.8 billion in damage across Shasta and Trinity counties in Northern California.

To put the 2017 and 2018 seasons into perspective for the insurance industry, there were only seven individual wildfires on record to surpass USD1 billion in inflation-adjusted losses at the end of 2016. That total is now 13.

Exhibit 25: Historical Billion-Dollar Insured Loss Wildfire Events



Source: Aon

Beyond the U.S., there were also notable wildfires in Greece and Australia in 2018. Greece's summer Attika Wildfires left 100 people dead and extensive damage to tourist-heavy locations in Mati, Rafina, Neos Voutzas, Agia, and Marina. Total insured losses neared USD40 million. Also in Europe, the combination of exceptional heat and dry conditions led to severe wildfires in Sweden. The forestry industry alone reported damage losses in excess of USD100 million. In Australia, extreme summer temperatures and expansive drought conditions led to dozens of bushfire ignitions in parts of New South Wales and Victoria. Total insured losses topped USD55 million.

It is worth further discussion regarding the recent uptick in major wildfire events in the United States and elsewhere around the globe. With the continued expansion of exposure and population into known fire locations, there is an increased risk of greater wildfire losses in the future. These known fire locations are typically defined as the Wildland Urban Interface (WUI) and Intermix. The Interface is the area of exposure which is located near the divide between urbanized and forested areas that usually have a higher risk of fire. The Intermix is an area where exposure is directly located within forested locations.

When taking WUI Interface and Intermix exposures and combining with changes in fire behavior and intensity, further weather pattern variability, elongated fire seasons, and climate change-driven enhancements, these peril risks are only amplified. The high financial toll caused by the peril has allowed for more direct conversation between the public and private sectors in how to handle wildfire mitigation. This would include potential changes to fire suppression tactics, the re-analyzing of allowing new construction into highly vulnerable fire locations and modifying building code requirements.

Exhibit 26: Notable 2017 and 2018 California Wildfire Perimeters and Wildland-Urban Interface

Source: SILVIS Lab

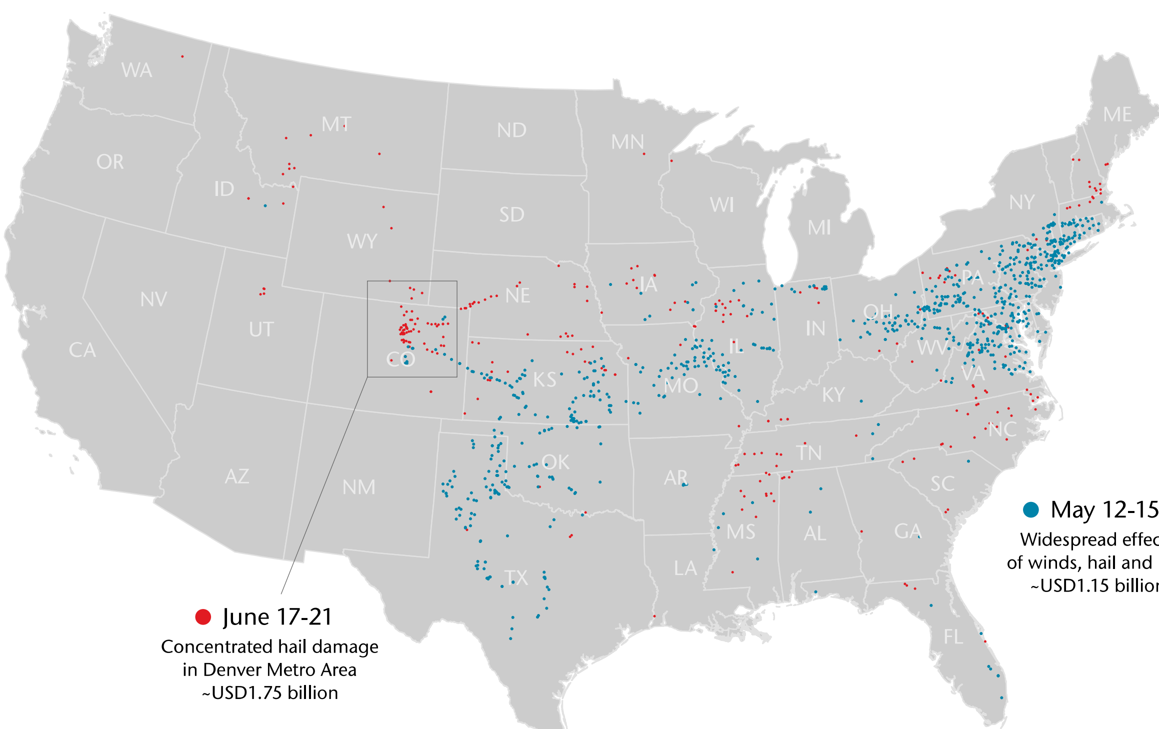
Peril Focus: Severe Weather

For the 11th consecutive year, global insurance industry losses due to severe weather exceeded USD15 billion. Most of these losses were again incurred in the United States. Severe weather – which references severe convective storms (SCS) – includes thunderstorm damage resulting from tornadoes, hail, straight-line winds, and flooding. The U.S. typically leads the globe in SCS losses in any given year due to its unique topography and geographic location that makes it particularly prone to outbreaks of severe storms.

The USD21 billion in economic damage from U.S. severe weather was driven by at least eight individual billion-dollar events. Despite a well below average year for U.S. tornadoes, including the first year since at least 1950 in which no F/EF4 or F/EF5 tornado was recorded, overall SCS-related damage was nearly 10 percent higher than 2000-2017 average. This highlights the continued hail and straight-line wind-driven nature of SCS losses. The year's costliest U.S. SCS event was a major June hail event in Colorado that left more than USD2.3 billion in economic damage, including in the greater Denver metro region. All eight of the billion-dollar events occurred in areas east of the Rocky Mountains. Of those eight events, six cost insurers at least USD1 billion.

The following graphic shows the spatial distribution of severe weather reports, provided by the Storm Prediction Center, which were recorded during the two costliest SCS-driven insurance events in the United States.

Exhibit 27: Storm Reports for the Two Costliest Insured U.S. SCS Events

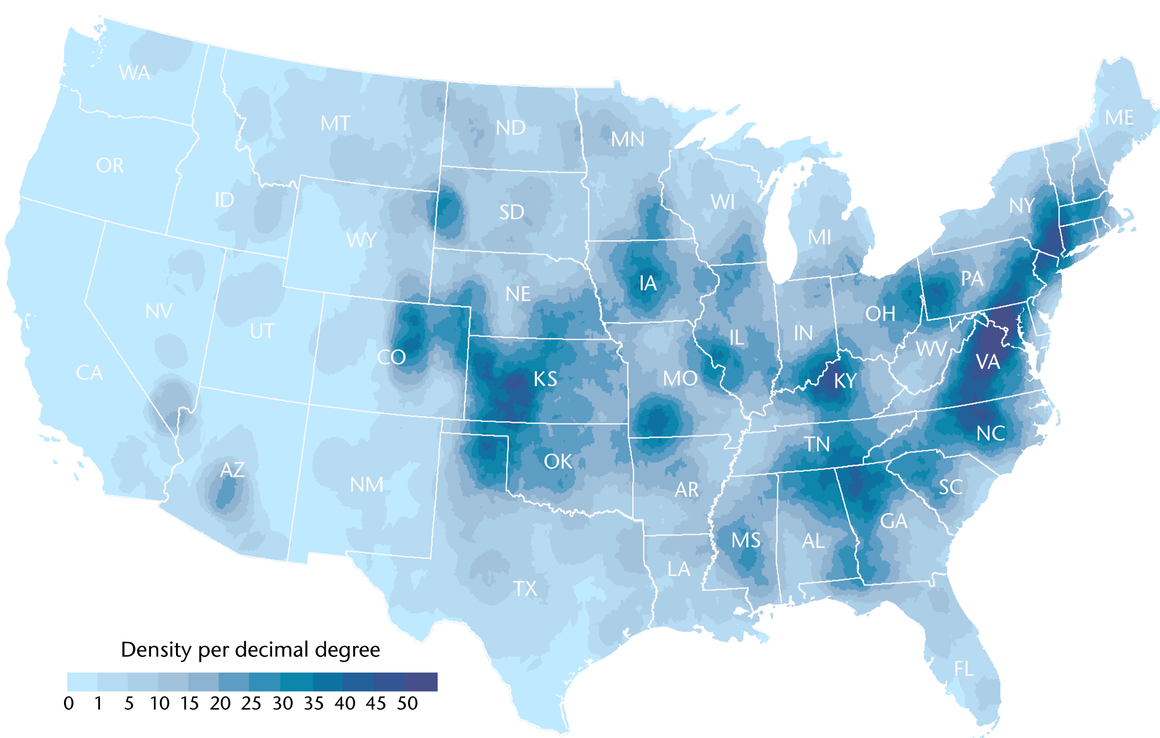


Source: NOAA

The United States is typically the overwhelming annual driver of SCS-related losses for the insurance industry. While parts of Europe and Asia Pacific are prone to outbreaks of severe weather, the U.S. often has a much greater frequency of events. Since 1990, the U.S. has accounted for 77 percent, or nearly USD300 billion, of all global insured losses for the SCS peril. EMEA is second at 15 percent (57 billion).

The following graphic shows the density of filtered severe weather reports per decimal degree, recorded in the United States throughout 2018. Hail, wind and tornado reports are included in the map below. The data is provided by the U.S. Storm Prediction Center and is to be considered preliminary until an updated and final dataset is released by the agency in early 2019. However, inferences can be made to show that the most active areas for thunderstorm events in 2018 were found across the Rockies, Plains, Midwest, Southeast, and the Northeast. Most of the hail and tornado reports were found in the Rockies, Plains, and Southeast; while an excessive number of straight-line winds impacted parts of the Mid-Atlantic and Northeast.

Exhibit 28: Density of 2018's Severe Weather Reports



Source: NOAA

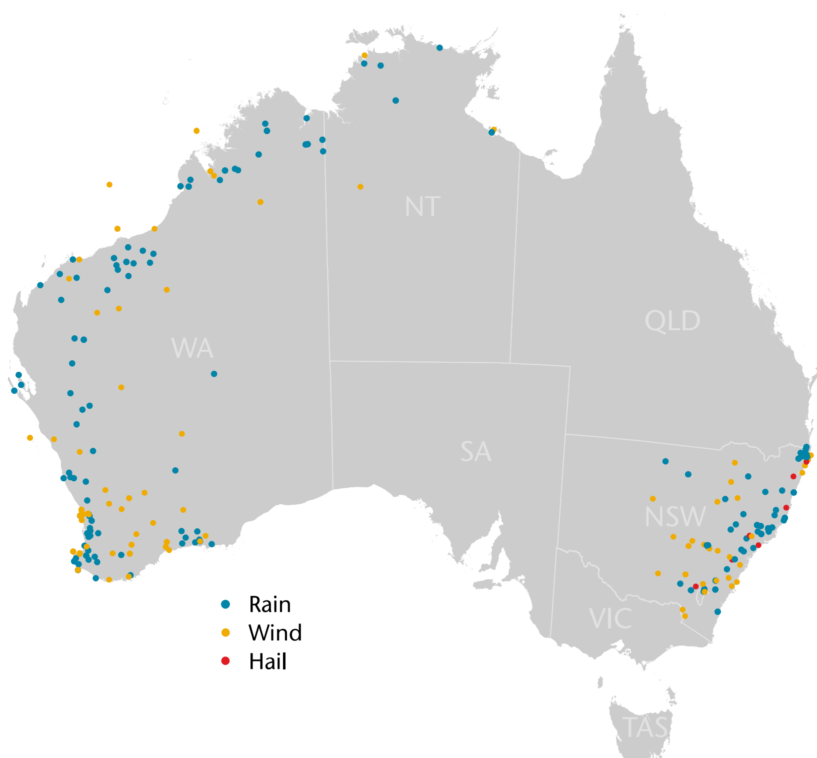
Beyond the United States, there were several notable severe weather events that had a significant financial toll. The most catastrophic hail event outside of the U.S. was a major hailstorm that struck the Sydney, Australia metropolitan region on December 20. Up to baseball-sized hail led to extensive damage to vehicles, homes, and businesses. Tens of thousands of insurance claims were filed with total payouts listed well into the hundreds of millions (USD); possibly higher.

Additional notable thunderstorm losses were incurred in Canada. The country's costliest event was a powerful May series of windstorms that swept through the city of Toronto and elsewhere across the provinces of Ontario, Quebec, and Nova Scotia. Total claims payouts topped USD475 million. In late September, a series of tornadoes swept through Ontario and Quebec. This included a high-end EF3 tornado that left considerable damage in the city of Gatineau. Another EF2 tornado caused widespread damage in the Nepean region of Ottawa. Total insured losses from that outbreak topped USD235 million.

While Asia saw below average thunderstorm losses in 2018, Europe was faced with several notable events. The costliest stretch was recorded in Italy and the Alpine region at the end of October and into early November, when a Mediterranean cyclone resulted in a complex severe outbreak of heavy rain, hail, powerful winds, coastal flood and snowfall, causing an estimated economic cost of approximately USD5.0 billion.

On the other hand, Central and Western Europe recorded higher insured losses than Southern Europe. The main driver was a stretch of severe weather pattern during May and June, caused by a so-called 'Central European' area of low pressure. This setting resulted in a number of small, isolated flash flood and hail events throughout Germany, Benelux, France, Switzerland, and elsewhere. Although no individual event reached the significance of large disasters seen in the previous years, prolonged nature of the outbreak eventually led to notable insurance payouts. It can be concluded that storm flooding was the main driver of SCS losses in Europe in 2018.

Exhibit 29: Distribution of 2018's Severe Weather Reports in Australia



Source: Bureau of Meteorology

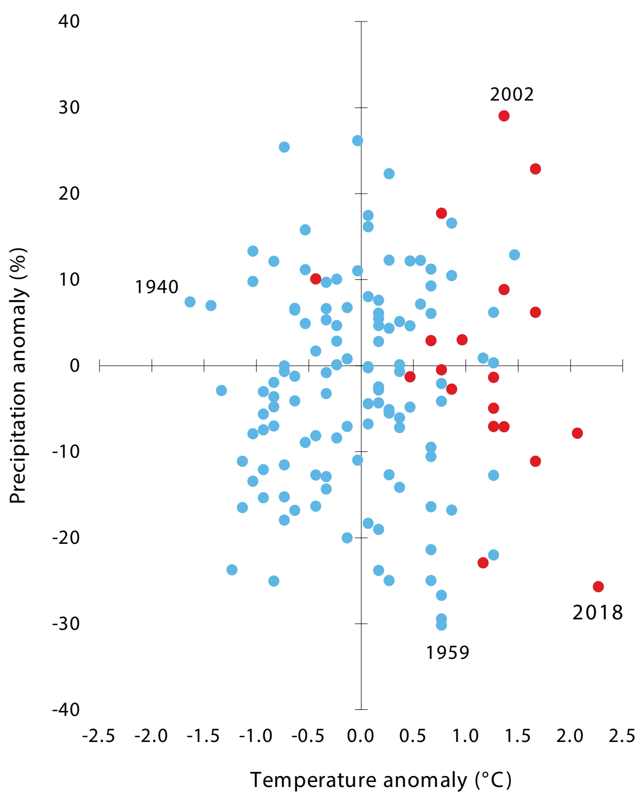
Peril Focus: Drought

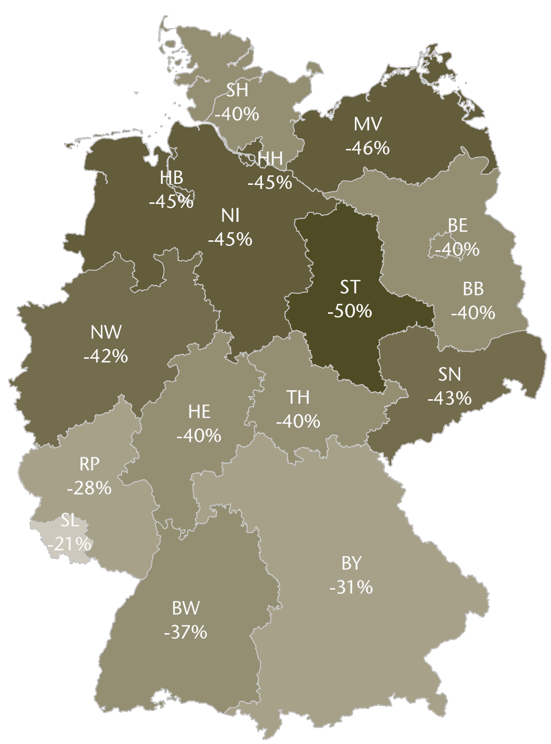
Among the costliest perils around the world in 2018 was drought. With a combined damage cost of more than USD27 billion, it marked the most expensive year for the peril since 2013. Among the hardest-hit areas were Central and Northern Europe, Central America, South America, South Africa, Asia, and the United States. Each of these regions incurred a multi-billion-dollar economic loss, with most of the losses incurred almost entirely to the agricultural sector.

The most expensive droughts were found in EMEA, notably across Central and Northern Europe. Agricultural impacts tallied roughly USD9 billion during the spring and summer months, which was highlighted by record heat and a severe lack of rainfall. All-time heat records were set in parts of Germany, Belgium, The Netherlands, Finland, Norway, and Sweden. During the peak of the heatwave, temperatures exceeded 90°F (32.2°C) as far north as the Arctic Circle and Scandinavia. The heat also coincided with one of the driest summers on record as persistent high pressure kept moisture away from a large portion of Europe. This further led to increased wildfire risk, as seen in parts of Sweden. These conditions combined to lead to a major reduction of crop yields and harvests. Many individual types of crops, such as wheat, grain, and vegetables, were reduced by as much as 70 percent. This led to the high financial toll.

The below graphics show how exceptional the year was for Germany, the most affected country. The data provided by Deutscher Wetterdienst (German Weather Service) suggest that 2018 was the warmest year on record, dating back to 1881. The year was also the fourth driest. The graph on the left shows the annual anomalies using the standard 1961-1990 climatological average, with years since 2000 shown in red. The right picture shows precipitation deficit in the period from April to September on state level, compared to normal.

Exhibit 30: Annual Temperature and Precipitation Anomalies in Germany





2018 Q2&Q3 precipitation anomaly

Similar conditions were found in South Africa. A lack of rainfall and above average temperatures during the harvest season of 2017/2018 into 2018/2019 led to a reduction of agricultural yield by more than 20 percent. Total economic losses surpassed USD1.2 billion (ZAR17.6 billion).

Drought conditions were additionally significant across Central America and South America. Some of the hardest-hit countries included Guatemala, El Salvador, Honduras, Panama, Argentina, and Uruguay. The aggregate agricultural cost in these countries topped USD6 billion. In the United States, a lack of rainfall and well above normal temperatures resulted in major crop damage in parts of the West, Northern Rockies, and the Plains. Total losses exceeded USD3 billion.

A shift in monsoonal patterns and timing also brought a multi-billion-dollar drought cost to parts of India and China. Much of India saw a severely reduced amount of seasonal rainfall, which aided in accelerated drought losses. Extended heat and a near-record lack of rainfall brought major drought conditions to New South Wales, Queensland, South Australia, and Victoria in Australia.

One of the primary causes of global drought conditions was the gradual shift towards El Niño during the year. El Niño has a notable impact on the shift of weather patterns that can make certain parts of the world much more prone to increased heat and minimal rains. It can also lead to more prolific rains elsewhere

Agriculture: the impact of natural catastrophes on insurance schemes in APAC

Christopher Coe, *Aon*

The agriculture sector is particularly vulnerable to natural catastrophes and we take a journey through Asia Pacific to explore the impact of drought, monsoons and floods in 2018.

The lack of rainfall in Eastern Australia was the worst in recent memory and was estimated to have caused more than USD1 billion in economic damage. In fact drought made headlines across the globe in 2018 as Central and Northern Europe, South America, China, India, and the United States also each recorded multi-billion dollar agricultural losses.

In Australia, this severely impacted the farming community as it experienced a 20 percent decline in year-to-year crop production. The country's attitude to crop insurance has always been at odds with the rest of the world, and they do not subsidize premiums. However, small steps are being considered like allowing insurance premiums to be exempt from tax. In addition, the AUD2 billion (USD1.4 billion) relief package put aside for farmers in 2018 may cause a rethink.

Similarly, the northeast of China often has challenges with rainfall deficit. This year was not too bad but it was the unseasonal frost that caused the major damage to agriculture. Meanwhile to reduce volatility, the Chinese government is considering pooling the entire agriculture insurance scheme and replacing the current structure which divides the risk amongst insurance companies.

In India the monsoon drives summer agricultural production, and this was patchy in 2018. The states of Rajasthan and Gujarat were particularly affected by a long dry spell from mid-August to the end of September where groundnut and soya bean production was notably affected. Although not specifically linked to the above losses, the Indian government is encouraging the states to pursue multi–year deals, rather than the current practice of per season or per annum insurance schemes. Three-year deals will fix the rates payable for the period, and only the deductible will vary a little, thereby mitigating the budgeting volatility for the states that heavily subsidize insurance premiums.

In Thailand the ongoing challenge for farmers is flood. In 2018, there was little flood activity but there were some dry spells, which did impact rice production in the northeast. The insurance scheme will pay claims for these losses but the sum insured is only a maximum of 50 percent of the total production cost. This insurance is currently free for many farmers and the Thai government is helping farmers to become more financially educated and involved. They are therefore introducing in 2019 a product where the individual farmer can pay a small premium and increase his sum insured. The aim is to increase this contribution, so farmers become more self-sufficient.

Natural catastrophes remain a key risk for agriculture in Asia Pacific but the good news is that the insurance industry can help – if governments are prepared to increase their budgets and invest in more comprehensive insurance schemes. The abundance of capital in the market means that there is potential for further and more robust insurance schemes to support a burgeoning agriculture industry.

Natural catastrophes remain a key risk for agriculture in Asia Pacific but the good news is that the insurance industry can help – if governments are prepared to increase their budgets and invest in more comprehensive insurance schemes.

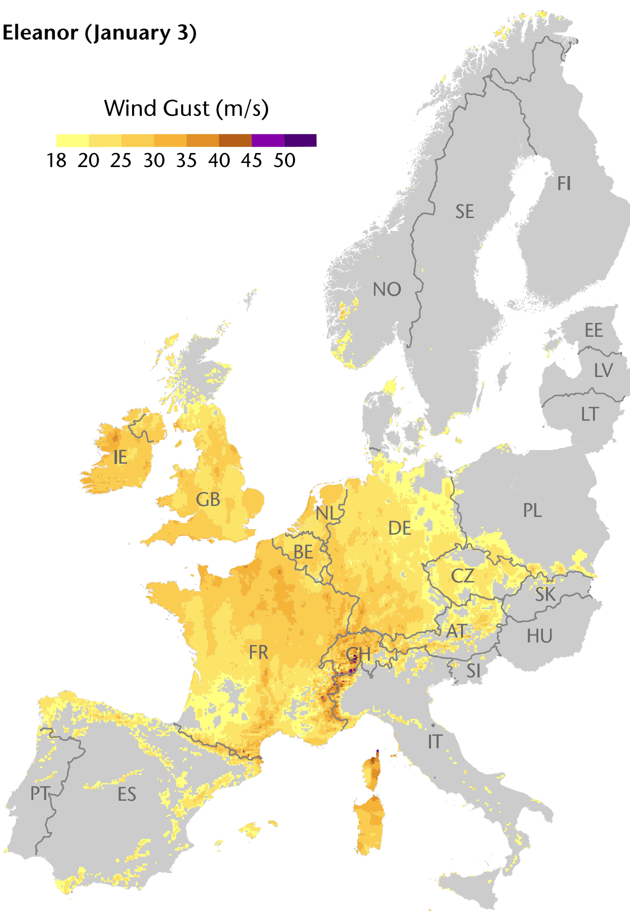
Peril Focus: European Windstorm

2018 was marked by two significant windstorm events in Europe at the beginning of the year. The first days of January brought a relatively weak storm Carmen, which was shortly followed by a powerful extratropical cyclone Eleanor, also known as Burglind, on January 3. The combined impact of these two storms on European insurers exceeded USD900 million. Windstorm Friederike swept through Western and Central Europe on January 18, on the 11th anniversary of Windstorm Kyrill, and triggered insurance payouts in excess of USD2.0 billion, thus becoming the costliest windstorm event since Xynthia swept through Europe in February 2010. In Germany and the Netherlands, Friederike even became the costliest since Kyrill in 2007. From the European perspective, Friederike currently ranks as the fifth costliest storm of the 21st century, behind Kyrill, Klaus, Xynthia, and Erwin (Gudrun).

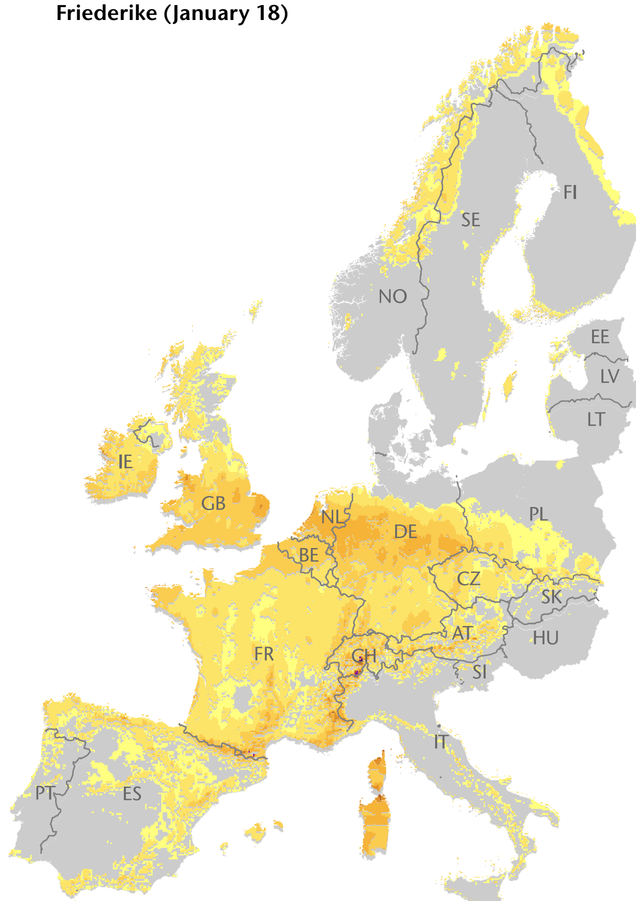
As a result of these costly events, 2018 can be described as above-normal in terms of incurred insurance loss, despite the relatively low number of significant storms since January. This can be confirmed comparing the loss totals with long-term averages since 2000 and even 1990. Below are the footprints of the two most significant storms of 2018, generated by Aon's Impact Forecasting team in less than 24 hours after their peak, using measured station data of wind gusts. Impact Forecasting also provides a service for projecting a storm's impact prior to the event, using meteorological prediction data.

Exhibit 31: Impact Forecasting's footprints of Windstorms Eleanor and Friederike

Eleanor (January 3)



Friederike (January 18)



Peril Focus: Other Perils

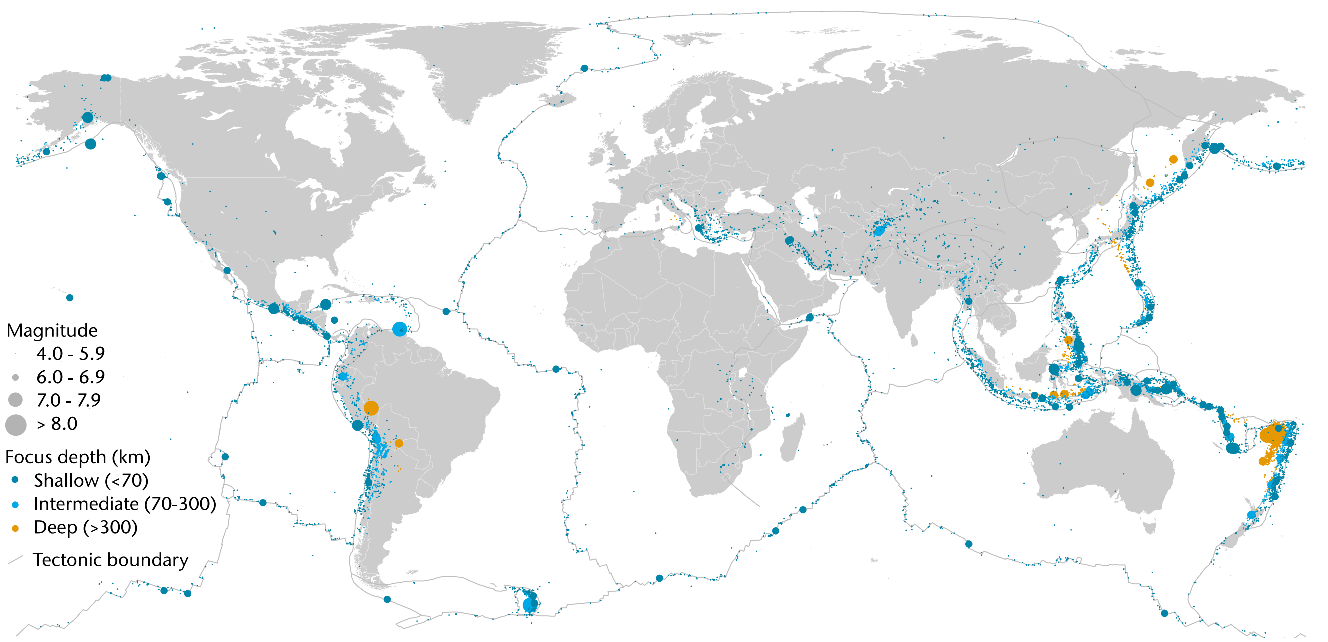
The costliest individual **flood** event of the year occurred in Japan during the month of July. The event was initiated by the arrival of the seasonal "Meiyu Front" – a typical monsoon season phenomenon – that was enhanced by the passage of Typhoon Prapiroon. Exceptional rainfall swept across parts of Okayama, Hiroshima, Tottori, Fukuoka, Saga, Nagasaki, Hyogo, and Kyoto prefectures, as flash floods and mudslides left at least 246 people dead. Total economic damage was listed at nearly USD10 billion, with the General Insurance Association of Japan citing insurance payments of up to USD2.7 billion. Other major multi-billion-dollar floods in Asia included events along the Yangtze River Basin and northern sections of China, and monsoon season floods in the Indian state of Kerala. Heavy January rainfall in Southern California led to USD900 million in damage in burn scar areas following 2017's Thomas Fire.

Earthquakes triggered more than USD9 billion in economic losses during 2018; its lowest total since 2006. However, despite the reduced losses, there were several events which had a significant impact. The deadliest events of the year were attributed to earthquakes that struck Indonesia on September 28 (2,256 deaths) and August 5 earthquake (560 deaths). The tremors left catastrophic damage in Sulawesi and Lombok, respectively, as more than 200,000 homes and other structures were damaged or destroyed by either ground shaking or tsunami waves. Total economic losses neared USD2.3 billion. In Japan, a strong earthquake impacted Osaka on June 17, leading to insured losses of at least USD935 million. Another Japan earthquake struck Hokkaido on September 5, which left dozens dead and caused more than USD1.7 billion in damage. In the United States, a magnitude-7.0 tremor struck near Anchorage, Alaska on November 30. Most damage was incurred to infrastructure and indoor building contents as losses topped USD150 million.

A **volcano** in Guatemala – Volcan De Fuego – erupted in June and left at least 190 people dead. In December, an underwater landslide following an eruption of the Krakatoa volcano spawned a major tsunami in Indonesia. More than 430 people were left dead.

Global **winter weather** damage topped USD13 billion in 2018; the highest for the peril since 2014. Europe's "Beast from the East" cold snap, plus multiple billion-dollar Nor'easter in the United States led damage costs for the peril. A spring cold snap also caused widespread agricultural damage in China.

Exhibit 32: Global Earthquake Activity in 2018



2018 Climate Review

Global Temperatures & ENSO

2018 became the fourth warmest year on record dating to 1880 and was the second warmest year (behind 2017) without the direct influence of an El Niño event. Preliminary data indicated that 2018 was 0.78°C (1.4°F) warmer than the historical norm. Using official data provided by the National Centers for Environmental Information (NCEI), formerly known as the National Climatic Data Center (NCDC), it was also the 42nd consecutive year of above average global land and sea surface temperatures. Temperature anomalies are compared against NCEI's 20th century average (1901-2000).

Annual average temperatures in 2018 were likely influenced by a weak La Niña event during the first quarter of the year. La Niña typically leads to lowered global temperatures. On the other hand, the monitoring of sea surface temperatures in the Pacific showed sign of possible development of El Niño event during the fourth quarter.

It is worth noting that each of the five warmest years on record have occurred in the past five years: 2016, 2015, 2017, 2018 and 2014. Perhaps even more striking is that 19 out of the 20 warmest years have been registered since 2001. The lone exception being 1998 when the globe encountered one of the strongest El Niño events on record. An additional point of perspective is recognizing that the warmest year on record in 2016 at 0.94°C (1.69°F) is much more anomalous than the coldest year on record in 1908 at -0.44°C (-0.79°F).

To provide further context of the longevity of the earth's warming streak, the last below-average year for the globe occurred in 1976. At that time, global temperatures registered 0.08°C (0.14°F) below the long-term average. The last individual month to be below average was December 1984 at -0.1°C (-0.18°F). As of December 2018, that marked 407 consecutive months with above average temperatures.

Analyzing global temperature anomaly trends is important to track changes in climate. A temperature anomaly is simply the difference of an absolute (measured) temperature versus its longer-term average for that location and date. All major agencies that independently measure global temperatures use a combination of surface and satellite observations have each concluded that the Earth continues to get warmer. Some of these agencies include NOAA, NASA, the UK Met Office, and the Japan Meteorological Agency

Exhibit 33: Global Land and Ocean Temperature Anomalies: 1880-2018

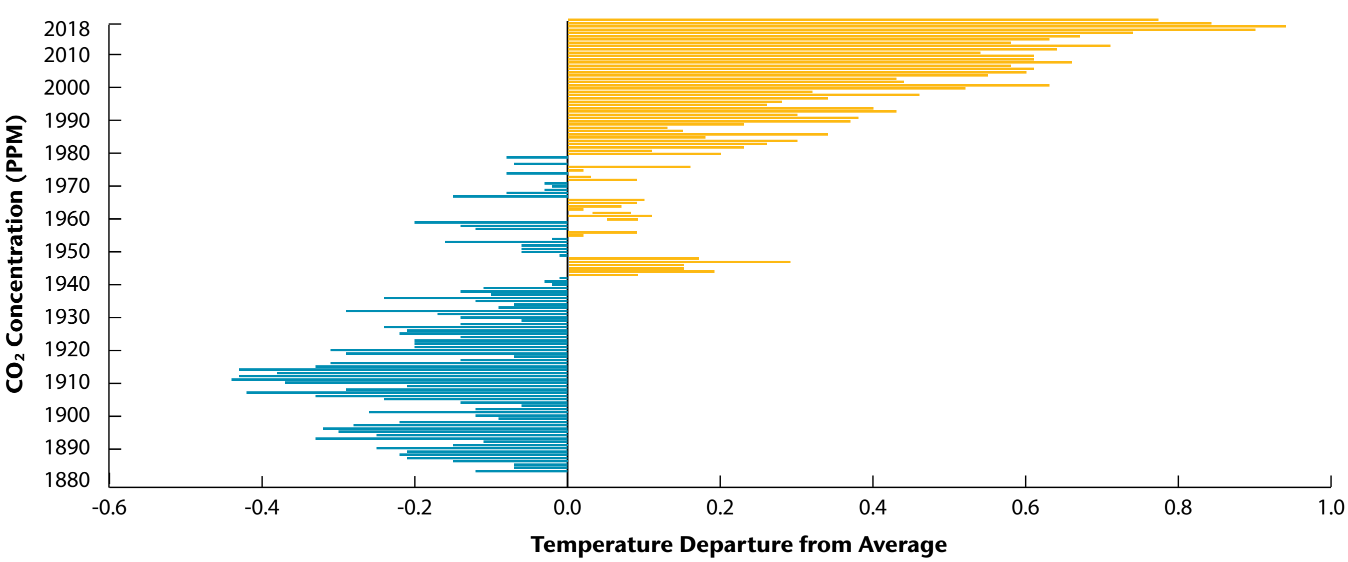
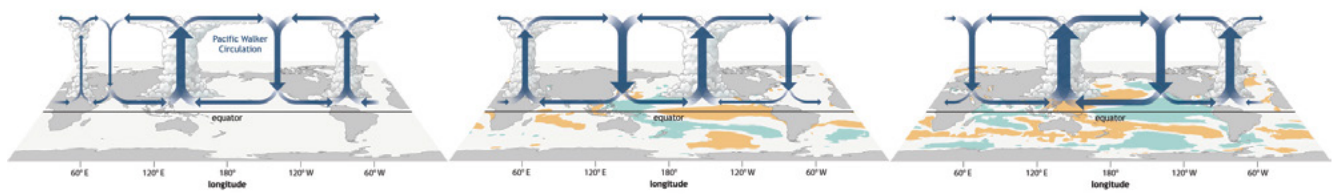


Exhibit 34: Phases of the El Niño/Southern Oscillation (ENSO)



Various ocean oscillations influence the amount of warming or cooling that takes place in a given year. The El Niño/Southern Oscillation (ENSO) is a warming or cooling cycle of the waters across the central and eastern Pacific, leading to a drastic change in the orientation of the upper atmospheric storm track. Warming periods are noted as El Niño cycles, while cooling periods are known as La Niña cycles. The Niño-3.4 Index, which measures the temperature of the ocean waters in the central Pacific, is used to determine ENSO phases/cycles.

According to data from the National Oceanic and Atmospheric Administration's (NOAA) Climate Prediction Center (CPC), 2018 was a year initially marked by a brief La Niña episode before transitioning to the boreal – Northern Hemisphere – spring.

Most of the year saw sea surface anomalies in the equatorial Pacific Ocean remaining between -0.5°C and +0.5°C; the threshold for ENSO-neutral conditions. By the end of the year, NOAA announced that warming waters in the Pacific Ocean highlighted the likelihood of an El Niño. These conditions were expected to linger through the first half of 2019. After that time, the forecast models indicated a likelihood of ENSO-neutral conditions returning by the end of the boreal spring months.

Please note that in order to be considered in an ENSO phase, NOAA requires a five consecutive, three-month running mean of sea surface temperature anomalies in the Niño-3.4 Region to be +0.5°C (El Niño) or -0.5°C (La Niña). The exhibit below highlights NOAA-defined ENSO calendar years in which these conditions were met.

Exhibit 35: ENSO Years Since 1900 (Red: El Niño / Blue: La Niña / Gray: Neutral)

1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
1901	1911	1921	1931	1941	1951	1961	1971	1981	1991	2001	2011
1902	1912	1922	1932	1942	1952	1962	1972	1982	1992	2002	2012
1903	1913	1923	1933	1943	1953	1963	1973	1983	1993	2003	2013
1904	1914	1924	1934	1944	1954	1964	1974	1984	1994	2004	2014
1905	1915	1925	1935	1945	1955	1965	1975	1985	1995	2005	2015
1906	1916	1926	1936	1946	1956	1966	1976	1986	1996	2006	2016
1907	1917	1927	1937	1947	1957	1967	1977	1987	1997	2007	2017
1908	1918	1928	1938	1948	1958	1968	1978	1988	1998	2008	2018
1909	1919	1929	1939	1949	1959	1969	1979	1989	1999	2009	

Source: NOAA

Global Carbon Dioxide

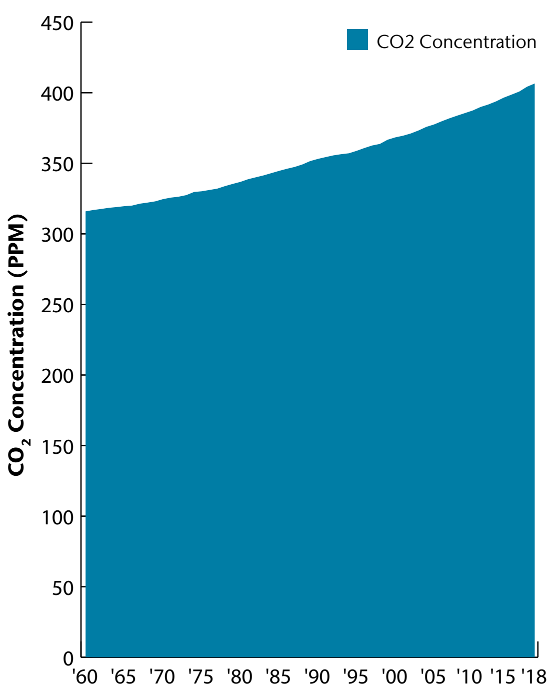
According to the data provided by the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory (ESRL), global carbon dioxide (CO2) levels averaged 406 Parts Per Million (PPM) in 2018. Monthly average concentrations on Mauna Loa Observatory in April, May and June exceeded 410 ppm for the first time in history. Similarly, the concentrations did not fall below 405 ppm in any month for the first time. The highest average value was measured in May and reached 411.2 ppm.

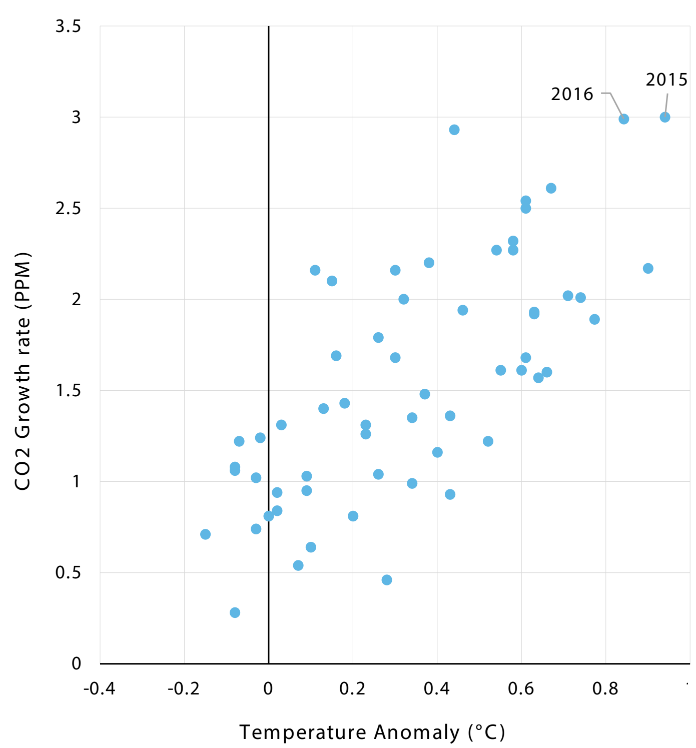
Atmospheric CO2 levels have a scientifically-proven correlation with global temperature, supported by data from ice cores and the geological record. Concentrations annually peak in May as plants begin to grow in the Northern Hemisphere with the arrival of spring, and a decline occurs during the month of September as growing season draws to a close.

CO2 is just one of several atmospheric gases that contribute to the "greenhouse effect"; others include water vapor, methane, nitrous oxide, and chlorofluorocarbons (CFCs). However, carbon dioxide is universally considered the largest contributor to the effect—currently 63 percent.

It is worth noting that annual rate of growth in CO2 concentrations has been increasing for decades. The annual mean rate of growth of CO2 in a given year is the difference in concentration between the end of December and the start of January of that year. If used as an average for the globe, it would represent the sum of all CO2 added to, and removed from, the atmosphere during the year by human activities and by natural processes. NOAA also applies a 4-month interpolating technique to account for month-to-month variability, which might be caused by weather patterns.

Exhibit 36: Average Atmospheric CO_2 Concentrations & CO_2 Growth Rate + Temperature Anomaly Plot (1960-2018)





Global Sea Ice Extent

The well-documented decline of sea ice extent and volume results in important climatic feedback mechanisms that affect global circulation patterns. Surface air temperatures in the Arctic region have been increasing at a rate twice as high as the global value, with far-reaching impacts for the entire Arctic ecosystem. Some of these impacts include a reduction in natural habitats, but also increased accessibility of the Arctic Ocean for shipping. Both Arctic and Antarctic sea ice extents were well below their averages in 2018.

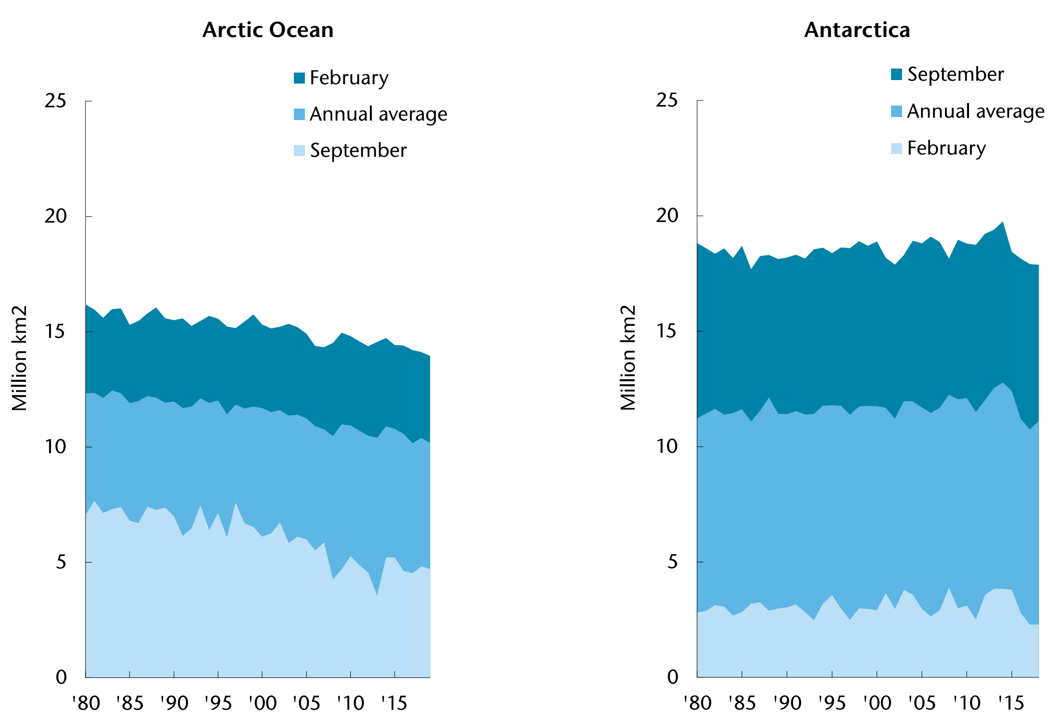
The Arctic region saw daily levels during much of January and February at record lows and eventually the wintertime maximum in March became the second lowest maximum on satellite record dating back to 1979. The September minimum extent was the sixth lowest on record at 4.59 million km² (1.77 million mi²).

One of the most important aspects of 2018 was the ice extent in the Bering Sea, which showed record low values during the entire 2017/18 winter season and continues to do so in the current winter of 2018/19. This was mainly attributed to a persistent southerly circulation that brought warm air and surface water from the south.

Sea ice extent in the Southern Ocean does not show signs of a clear, long-term declining trend. On the other hand, February 2018 saw the second lowest seasonal minimum of Antarctic sea ice extent on satellite record at 2.18 million km² (842,000 mi²), second only to 2017. However, these all-time lows come after a period of record highs recorded in 2013-2015.

While an important metric, sea ice extent does not tell the complete story of the health of the Arctic and Antarctic circles. Age and depth of sea ice is a critical component to this type of analysis. Younger and thinner ice permits more heat to escape into the atmosphere. This in turn causes Arctic and Antarctic air and sea surface temperatures to warm.

Exhibit 37: Global Sea Ice Extent 1980-2018



Source: Fetterer, F., K. Knowles, W. Meier, M. Savoie, and A. K. Windnagel. 2017, updated daily. Sea Ice Index, Version 3. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N5K072F8. [1/5/2018].

Corporate and Public Resilience Efforts: The Need for Alignment

Greg Lowe and Stefan Startzel, *Aon*

Recent trends in natural disaster activity – as highlighted in this report – are putting pressure on insurers to look to the future and manage evolving climate risk. But this is also an opportunity for the industry by encouraging investors, lenders, insurers and policymakers to explore how they can best manage and respond to increased physical risks of climate change using insurance products and industry knowledge.

This aligns to the Financial Stabilities Board's Task Force on Climate-related Financial Disclosures (TCFD) which recommends that physical risk is included on organizations' annual filings to build corporate resilience. This aims to provide investors with more transparency to efficiently allocate capital and manage systemic financial risks – at the same time as protecting individual assets for sustainable business continuity management and strengthened balance sheets. TCFD has the potential to grow investor interest in this topic, which could lead to increased demand for catastrophe solutions and parametric weather products.

On the whole, corporates are well-versed in managing individual risks but there remains two disconnects:

1. **The desire for companies to receive a financial reward in return for increased resiliency**, either through premium discounts or access to additional capital, versus what insurers are typically prepared to offer. The role of insurance in helping finance and reward corporate resilience efforts needs much deeper investigation.

2. **Corporates do not operate in a vacuum. They depend on suppliers and public assets, like infrastructure.** These critical supply chain vehicles are the lubrication for economic activity and are exposed to their own resilience challenges. Infrastructure is still substantially underinsured. Cooperation between policymakers, urban planners, risk managers, engineers, investors, and insurers needs to be much deeper to build economy-wide resilience. In this process, new approaches and products for risk management and transfer are likely to blossom.

Resilience Partnerships in Practice

Urban Land Institute (ULI)

The City of Miami Beach faces the triple challenge of extreme hurricanes, rising sea levels, and intense rainfall. This requires resilient infrastructure and sustainable finance so the ULI brought together nine experts, including Aon, from a range of disciplines to assess Miami Beach's adaptation strategy. The group provide advice on how to benefit businesses and citizens from better integrating the risk management function with resilience efforts to parametric products for the city to deal with chronic climate risk.

New Zealand Councils

Aon is working with over 50 local councils across New Zealand to help them identify the critical risks their infrastructure faces from natural hazards. In partnership with a local engineering firm, Aon has developed a new approach to modelling infrastructure that allows some of the risk to be transferred while protecting public balance sheets and creating a more resilience environment for businesses of all sizes across the country.

Cooperation between policymakers, urban planners, risk managers, engineers, investors, and insurers needs to be much deeper to build economy-wide resilience.

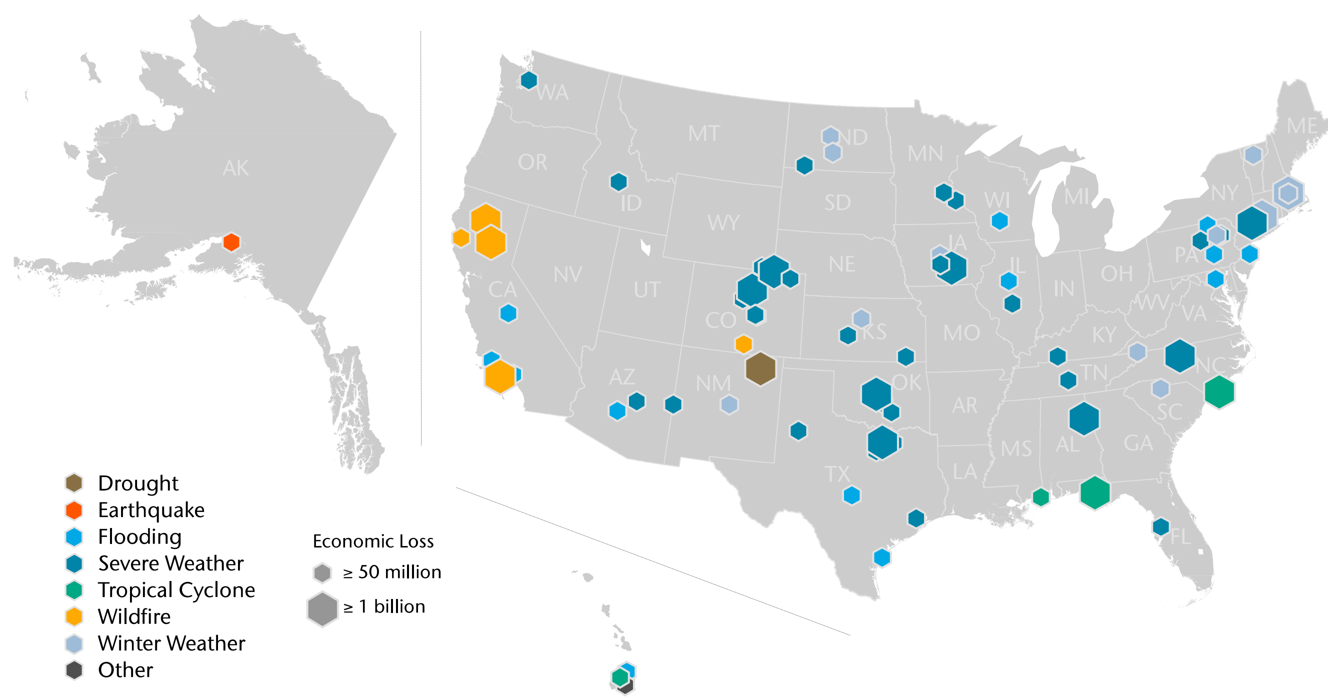
United States

Exhibit 38: Top 5 Most Significant Events in the United States

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
November	Camp Fire	California	88	15 billion	12 billion
October	Hurricane Michael	FL, GA, AL, NC, SC, VA	32	17 billion	10 billion
September	Hurricane Florence	NC, SC, VA, GA	53	15 billion	5.3 billion
November	Woolsey Fire	California	3	5.8 billion	4.5 billion
June 17-21	Severe Weather	Rockies, Plains, Midwest, Northeast	3	2.3 billion	1.8 billion
		All Other Events	~191	~37 billion	~23 billion
		Totals	**~370**	**~92 billion**	**~57 billion[1,2]**

1 Subject to change as loss estimates are further developed
2 Includes losses sustained by private insurers and government-sponsored programs

Exhibit 39: Significant 2018 Economic Loss Events[1]



[1] Based on events that incurred economic loss greater than USD50 million. Position of an event is determined by the most affected administrative unit or epicenter.

Economic and insured losses derived from natural catastrophes in the United States were elevated for a second consecutive year in 2018. The overall economic total was an estimated USD92 billion, of which USD57 billion was covered by public and private insurers. When compared to annual data from 2000-2017, economic losses in 2018 were +12 percent than the average (USD81 billion) and an even greater +97 percent from the median (USD46 billion). Insured losses were +48 percent higher than average (USD39 billion) and a further +133 percent higher than the median (USD24 billion).

Despite not incurring a major singular catastrophe which caused more than USD25 billion in economic damage, the U.S. was impacted by several mid- and smaller-sized events which quickly aggregated. The costliest economic event was Hurricane Michael, which struck the Florida Panhandle as a borderline Category 4/5 hurricane in October. The storm caused extensive wind and storm surge damage in Florida – notably Mexico Beach, Panama City, and Port St. Joe – before later maintaining Category 3 intensity into southern Georgia. This was the first Category 3 storm to impact Georgia since 1898. Widespread damage to property, infrastructure, and agriculture was recorded across the Southeast and Mid-Atlantic States. Total economic losses were estimated at USD17 billion.

The other significant hurricane event of 2018 in the U.S. was September's Hurricane Florence. The one-time Category 4 storm saw its wind speeds weaken considerably prior to making landfall in North Carolina, but it also slowed its forward motion while coming ashore. This prompted considerable inland flooding across North Carolina, South Carolina, and Virginia. Florence spawned record-breaking rainfall in the Carolinas that equaled to at least a 1-in-1,000 year return period; or a 0.1 percent chance of occurring in any given year. Both North and South Carolina established new rainfall records from a tropical cyclone. Total economic losses were estimated at USD15 billion, though only one-third of the damage was covered by insurance due to low flood insurance penetration.

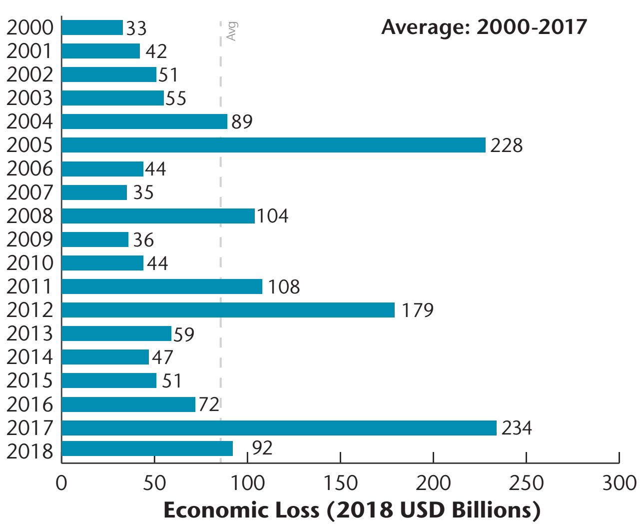
The costliest event of 2018 for the insurance industry was California's Camp Fire. The November wildfire damaged or destroyed nearly 20,000 structures alone and left at least 88 people dead. It became the most destructive and deadliest wildfire on record in California. The fire destroyed much of the city of Paradise. Total insured losses were estimated at USD12 billion, though loss development into 2019 may result in a higher final tally. California was also impacted by two other major wildfires: November's Woolsey Fire in Ventura and Los Angeles counties and July's Carr Fire in Shasta and Trinity counties. The Woolsey Fire, which destroyed more than 1,640 structures in a high-value area of Southern California, prompted insurance payments of roughly USD4.5 billion. The Carr Fire destroyed at least 1,604 structures in Northern California and led to more than USD1.2 billion in insured losses. These totals are also subject to change. Also of note, major January flooding and mudslides in Southern California occurred in burn scar areas following 2017's Thomas Fire. Total economic damage neared USD900 million.

The state of Hawaii endured several noteworthy natural disaster events in 2018. The most consequential was the multi-month eruption of the Kilauea Volcano on the Big Island that destroyed many small nearby communities and led to business interruption in tourist locales. Total economic losses were listed at USD800 million. Hawaii was also affected by August's Hurricane Lane, which prompted torrential mountain rainfall and flooding, and a landfall from a much-weakened Hurricane Olivia in September. Total economic damage from Lane was estimated at USD250 million. A major flood event in April left USD125 million in damage on the island of Kauai.

Other major U.S. events included a series of substantial hailstorms during the year that impacted parts of the Rockies and Plains. There were at least eight individual billion-dollar disasters attributed to severe thunderstorms. The costliest, which cost insurers at least USD1.75 billion in payouts, left extensive hail damage in Colorado. This included the greater Denver metro region. Further severe weather and flooding events were noted in the Midwest, Southeast, and Northeast during the year. A prolonged drought across the West and Plains additionally led to at least USD3 billion in economic damage; largely to agriculture. Two separate billion-dollar winter storms were registered in the Northeast and Mid-Atlantic during January and March.

Both economic and insured losses from natural disasters and weather-only events (excluding earthquakes and volcanoes) have consistently shown positive annual rates of growth since 2000. As population and exposure growth continues in some of the most vulnerable areas of disaster risk, this is expected to combine with any shifts in extreme weather variability and climate change to bring greater losses in future years.

Exhibit 40: United States Economic and Insured Losses (All Natural Disasters)



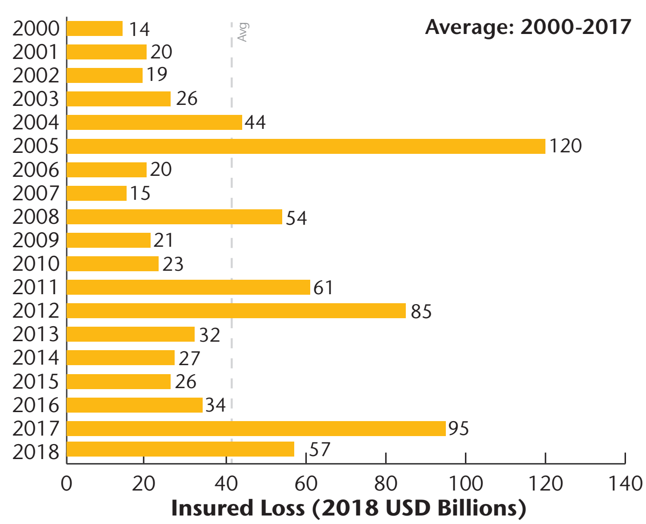
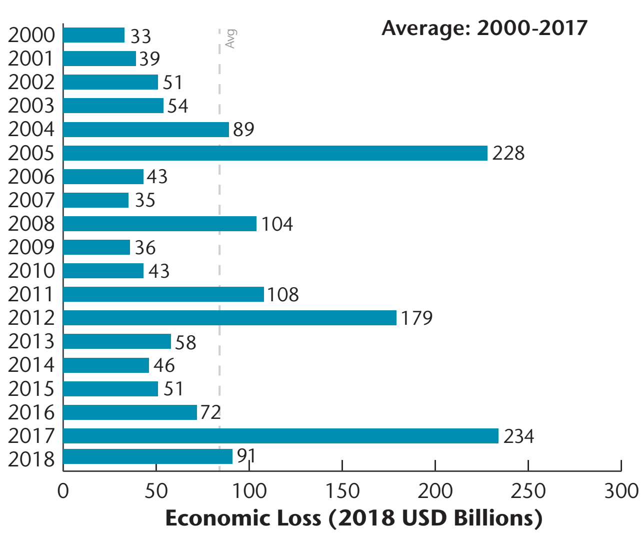
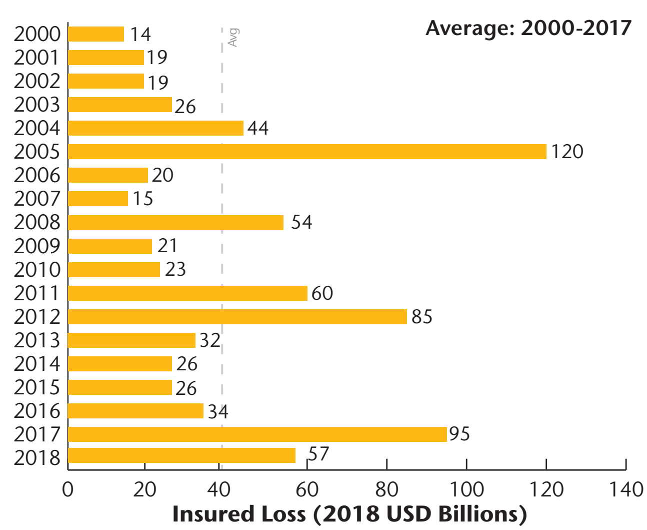


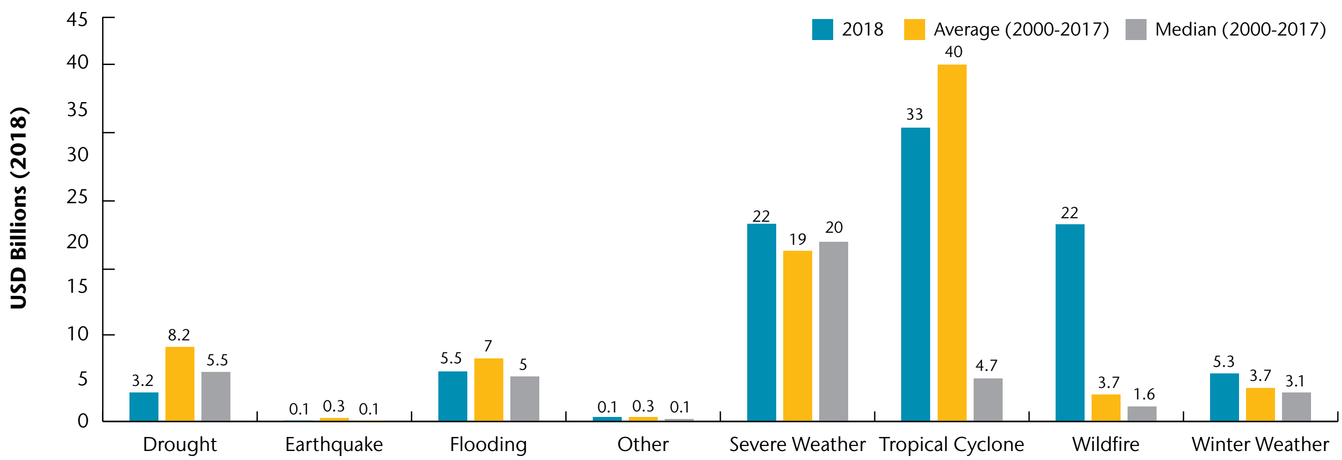
Exhibit 41: United States Economic and Insured Losses (Weather Only)





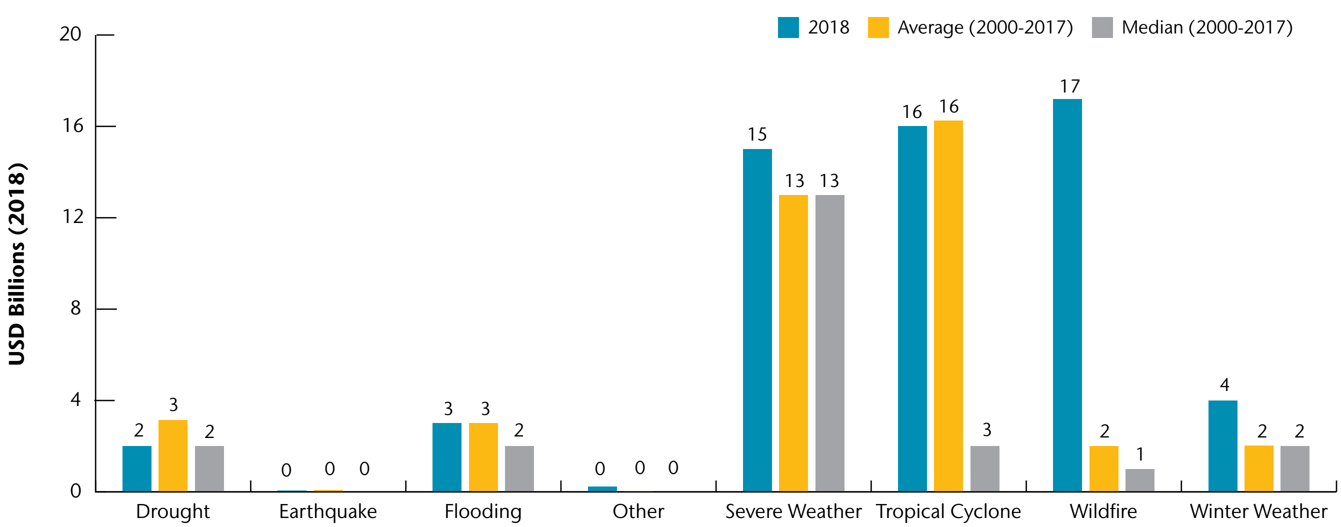
The dominant perils for economic losses in the United States were tropical cyclone, wildfire, and severe weather. The perils which ended above their 2000-2017 averages included wildfire, severe weather, winter weather, and 'other' which included losses associated with the Kilauea Volcano eruption in Hawaii. Despite the high cost of hurricanes Michael and Florence, the tropical cyclone peril finished below average but well above the median.

Exhibit 42: United States Economic Losses by Peril



For the first time on record, the wildfire peril was the costliest peril in the U.S. for public and private insurers. Substantial payouts associated with the Camp, Woolsey, and Carr Fires represented a majority of the more than USD17 billion in anticipated payouts for the year. Tropical cyclone was second at roughly USD16 billion, with severe weather third at nearly USD15 billion.

Exhibit 43: United States Insured Losses by Peril

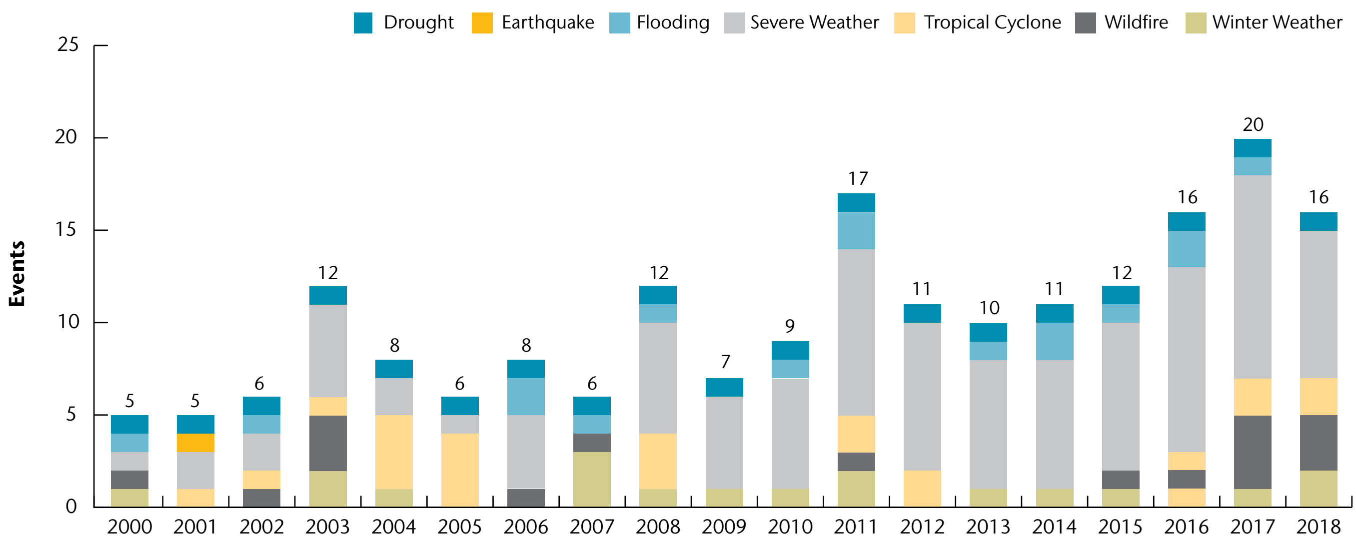


Please note that insured losses include those sustained by private insurers and government-sponsored programs such as the National Flood Insurance Program and the Federal Crop Insurance Corporation (run by the USDA's Risk Management Agency

There were at least 16 events that caused at least USD1 billion in economic losses in 2018, which was well above the 18-year average of 10. All of the events were weather-related as the U.S. did not incur a catastrophic earthquake for yet another year. Severe weather (thunderstorm) was again the leading peril for billion-dollar events.

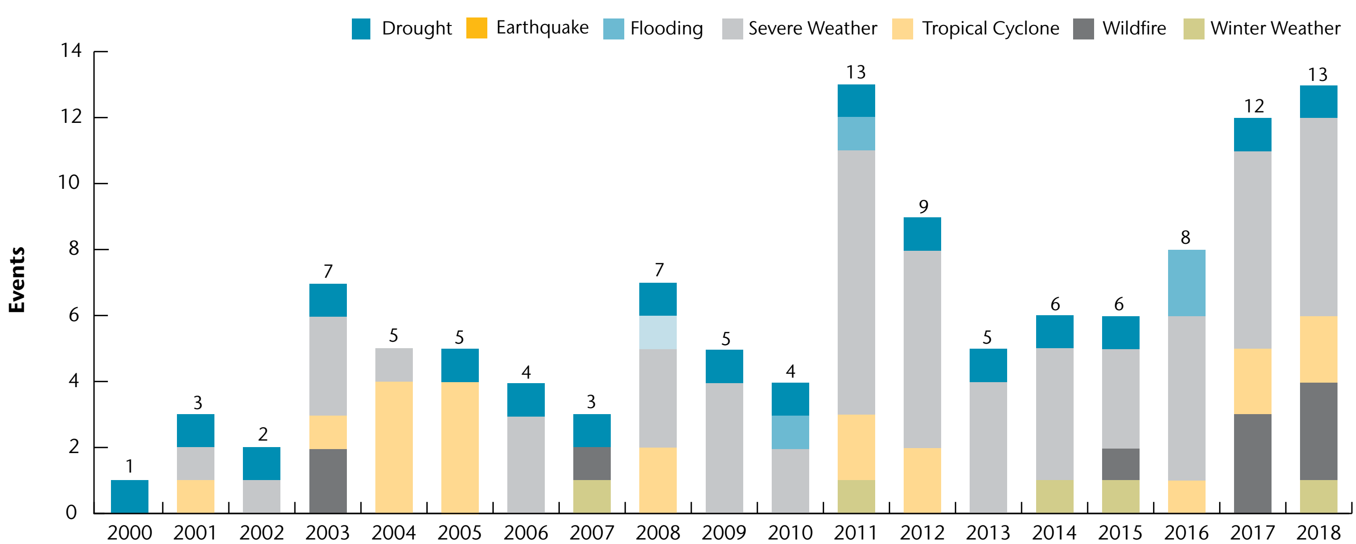
Please note that this analysis treats individual wildfires as their own billion-dollar events if they surpass the threshold. It is not treated as a singular aggregate (such as how NOAA categorizes fires).

Exhibit 44: United States Billion-Dollar Economic Loss Events



There were 13 events that triggered insurance payouts beyond USD1 billion, which was above the 2000-2017 average of 6. The 25 billion-dollar insured loss events in 2017 and 2018 mark the highest two-year total on record. All of the events were weather-related.

Exhibit 45: United States Billion-Dollar Insured Loss Events



Wildfires – Conflagration Continues

The Insurance Institute for Business & Home Safety (IBHS)

The 2018 California wildfires, including the Carr, Camp and Woolsey Fires put exclamation points on the frightening lessons offered by the Tubbs and other 2017 wildfires. Coffey Park demonstrated last year that wildfire risk extends well past the Wildland Urban Interface (WUI) and reaches right into tidy suburban neighborhoods. At that point, the structures themselves become part of the spreading wildfire, a risk that is not included in the models used to develop hazard zones in California.

As a result, the vulnerability of thousands of communities and neighborhoods remains a significant knowledge gap that must be closed. In the meantime, home and business owners need to adopt a more defensive mind set. We cannot wait for definitive labels – which a wildfire can readily disregard – while the countryside burns.

Wildfire doesn't have a single, lasting solution at any level. State and federal efforts can improve funding and execution of ongoing forestry management and wildland vegetation strategies, along with additional training and capacity to fight wildfires. These defenses are powerful, but require time, political courage and community will. Meanwhile, homeowners should follow the age-old wisdom that the best offense is a great defense, and work to mitigate risk.

Here again, wildfire mitigation is not a one-and-done effort. It requires vigilance, maintenance, and team spirit. Even the most fire-resistant property can burn if neighbors around it ignite. Wildfire resilience is an all-for-one, one-for-all activity. All homeowners should be aware of these details:

- Maintain defensible space
  - A 5-ft non-combustible zone surrounding the house, where no combustible material is allowed, reducing the chance of wind-blown embers igniting materials near your home, thereby exposing it to flames
  - A 5-30 ft zone, creating a landscape that will not readily allow fire to burn to the home
  - A 30-100 ft zone, reducing the energy and speed of the wildfire
- Use fire-resistant building materials
  - Class A roof assembly
  - Non-combustible siding or a 6-inch clearance from the ground to the siding
  - Use of metal drip edge to protect roof deck
  - Use of attic vents that mitigate against ember penetration

Paradise proved that burning structures can drive the spread of wildfires, and we need to add this data to wildfire risk models that inform hazard zones in California. The Joint Fire Services Program characterizes the differences between embers generated from vegetative fuels and structural fuels. Additional effort is required to incorporate this new information into fire spread models, and into the tools that differentiate the vulnerability of individual communities.

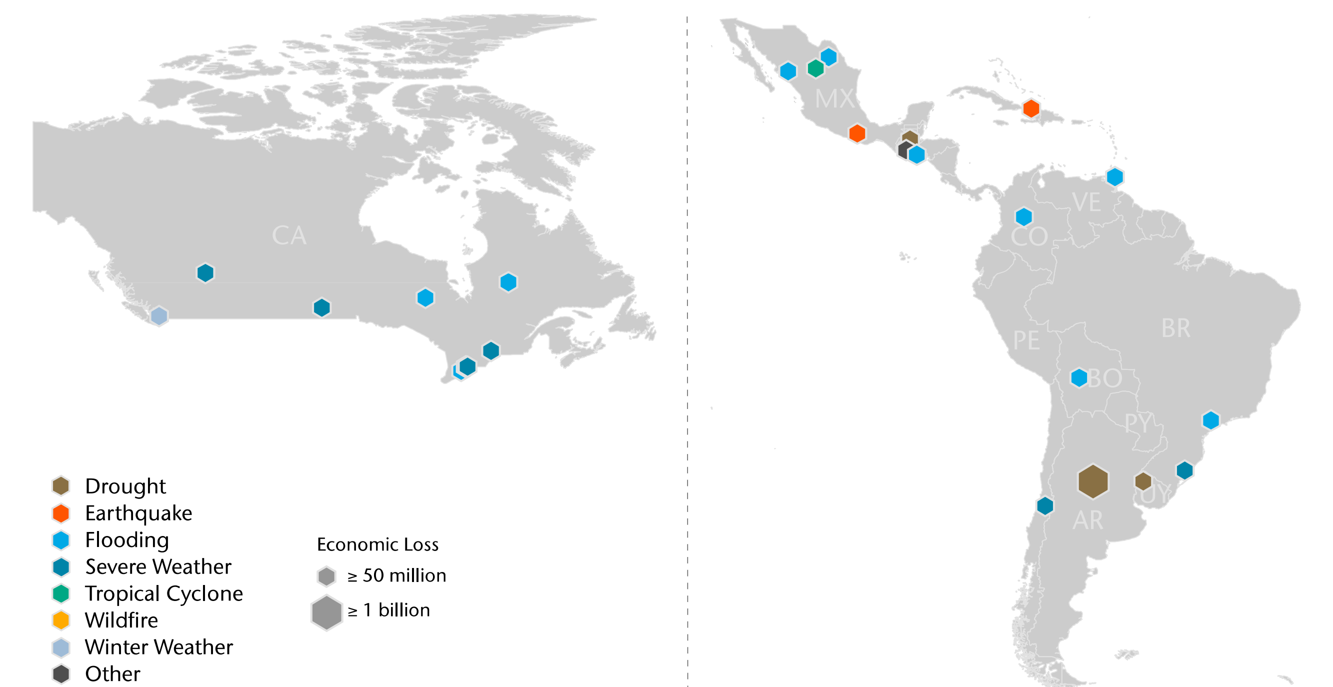
Wildfire mitigation is not a one-and-done effort. It requires vigilance, maintenance, and team spirit.

Americas (Non-U.S.)

Exhibit 46: Top 5 Most Significant Events in the Americas (Non-U.S.)

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
Spring & Summer	Drought	Argentina	N/A	5.1 billion	200 million
May 4-5	Toronto Windstorm	Canada	3	720 million	475 million
September 21	Severe Weather	Canada	0	325 million	235 million
September	Hurricane Willa	Mexico	0	500 million	25 million
June	Volca de Fuego	Guatemala	190	220 million	Unknown
		All Other Events	~132	~3.8 billion	~0.8 billion
		Totals	**~325**	**~10 billion[1]**	**~1.8 billion[1,2]**

Exhibit 47: Significant 2018 Economic Loss Events[3]



1 Subject to change as loss estimates are further developed
2 Includes losses sustained by private insurers and government-sponsored programs
3 Based on events that incurred economic loss greater than USD50 million. Position of an event is determined by the most affected administrative unit or epicenter.

Economic and insured losses from natural catastrophes in the Americas were significantly reduced in 2018. This followed record damage and insurance payouts from catastrophic hurricane events in 2017 (Irma and Maria). The overall economic total was listed at roughly USD10 billion. This is a major reduction from the USD144 billion incurred the previous year. Of the USD10 billion economic toll in 2018, just under USD2 billion was covered by public and private insurance entities. Based on annual data from 2000 to 2017, economic losses in 2018 were 50 percent lower than average (USD21 billion) and 20 percent lower compared to the median (USD13 billion). Insured losses were 57 percent below the average (USD4.6 billion) and just 10 percent lower than the median (USD2.2 billion).

The costliest event of the year across the Americas was recorded in South America. An extended drought in Argentina led to an economic impact of at least USD5.1 billion. This included a major reduction of wheat, dairy, and other crops as Argentina officials cited the drought as the country's worst in five decades. Notable droughts were also cited in Uruguay (USD500 million) and the countries of El Salvador, Guatemala, Honduras, and Panama in Central America (USD200 million). Much of these drought losses were tied to the transition from weak La Niña conditions early in the year to eventual El Niño conditions.

The majority of insured losses in the Americas were recorded in Canada. The country endured a series of mid-sized industry loss events, especially with the severe thunderstorm peril. The costliest was a powerful May series of windstorms that swept through the city of Toronto and elsewhere across the provinces of Ontario, Quebec, and Nova Scotia. Total claims payouts topped USD475 million. In late September, a series of tornadoes swept through Ontario and Quebec. This included a high-end EF3 tornado that left considerable damage in the city of Gatineau. Another EF2 tornado caused widespread damage in the Nepean region of Ottawa. Total insured losses from that outbreak topped USD235 million. Other notable Canadian events in 2018 included a flash flood event in Toronto (August), a large hailstorm in Calgary (August), and severe thunderstorms in Saskatchewan and Manitoba (June).

Following a year of catastrophic tropical cyclone impacts, there was much less activity in 2018. The most notable hurricane landfall was Hurricane Willa in Mexico during October. The Category 3 hurricane struck from the Eastern Pacific Ocean and brought widespread flood inundation and wind damage. Most of the USD500 million in damage was associated with impacts to infrastructure and agricultural assets. Further storms, though substantially weakened at the time of landfall in Baja California, included Rosa (tropical depression) and Sergio (tropical storm).

The most significant flood event was recorded in Mexico. The remnants of Tropical Depression 19 led to catastrophic inundation in the state of Sinaloa. As many as 300,000 homes were flooded. Prior to developing into Hurricane Michael, the disturbed area of low pressure spawned days of heavy rainfall in Central America. Total economic losses were estimated in excess of USD150 million. Additional seasonal flooding was recorded in parts of Brazil.

The deadliest event of the year for the Americas was the powerful eruption of Guatemala's Volcan De Fuego in June. The multi-day eruption left at least 190 people officially dead, though unofficial estimates list a much higher casualty toll, and many others injured. This was the deadliest eruption in Guatemala since 1929.

Earthquake activity was notable across many areas. The most damaging event was a magnitude-7.2 that impacted parts of Mexico's Oaxaca state and Mexico City. Total economic damage was at least USD100 million. Another high-impact earthquake was a magnitude-5.9 tremor that struck just off the northern coast of Haiti. At least 18 people were killed and nearly 20,000 homes and other structures were damaged or destroyed. Other notable events occurred in Venezuela, Peru, and Honduras though impacts in each were not widespread.

Both economic and insured losses from natural disasters and weather-only events (excluding earthquakes and volcanoes) have shown growth since 2000 in the Americas. However, there is definite skew given extreme loss years in 2010 and 2017. With population and exposure growth continuing to be substantial across parts of the Caribbean and Latin America, the prospect of more high-dollar losses is expected to combine with any shifts in extreme weather variability and climate change.

Exhibit 48: Americas (Non-U.S.) Economic and Insured Losses (All Natural Disasters).

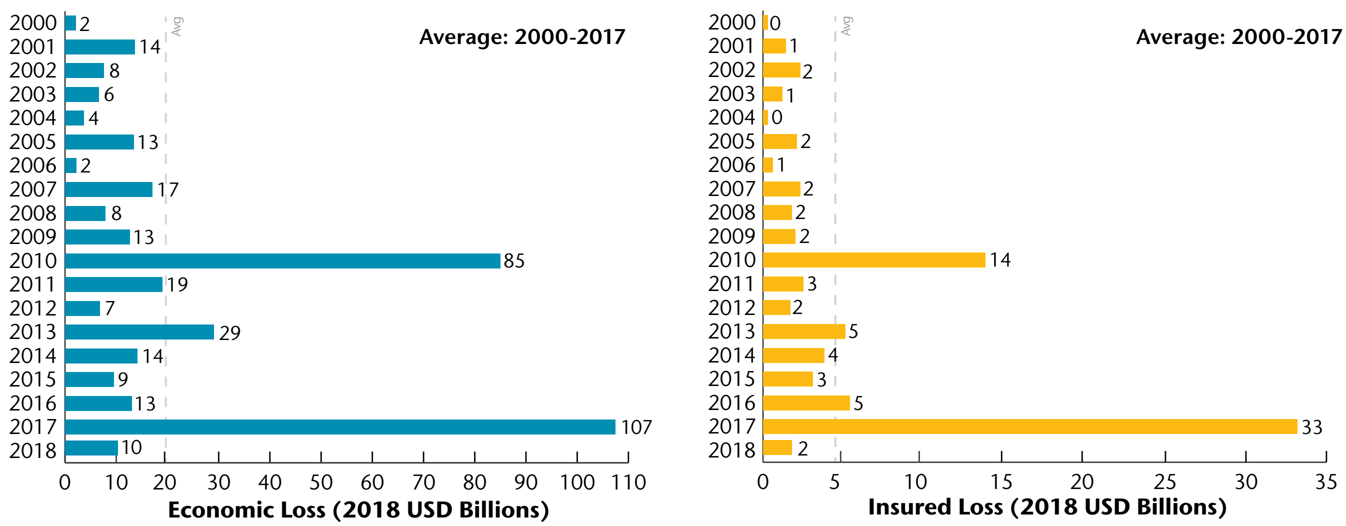
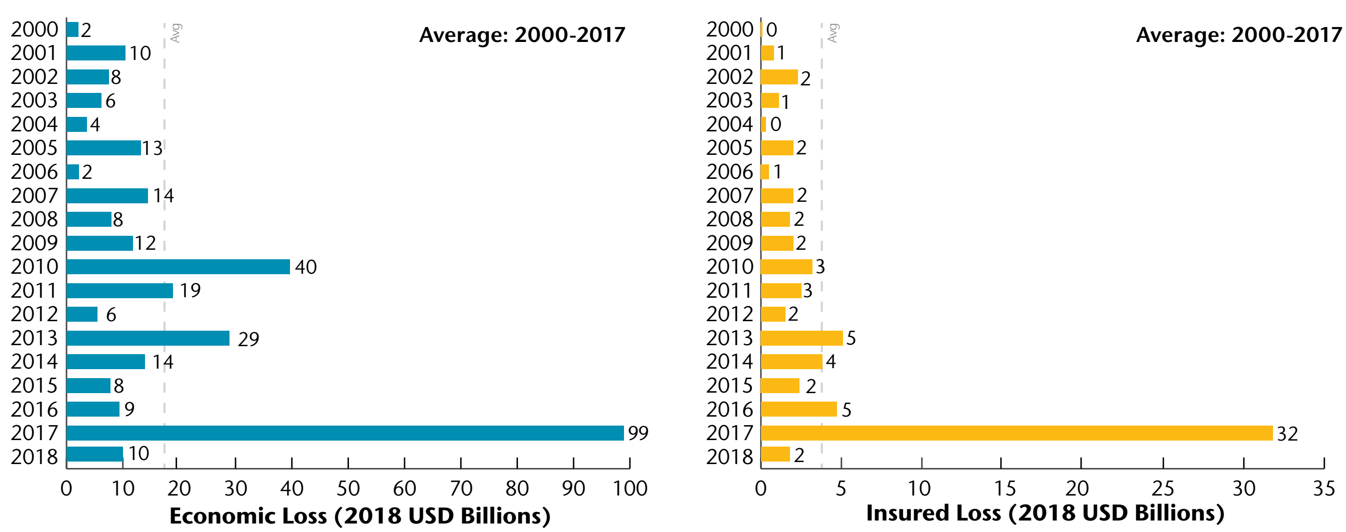
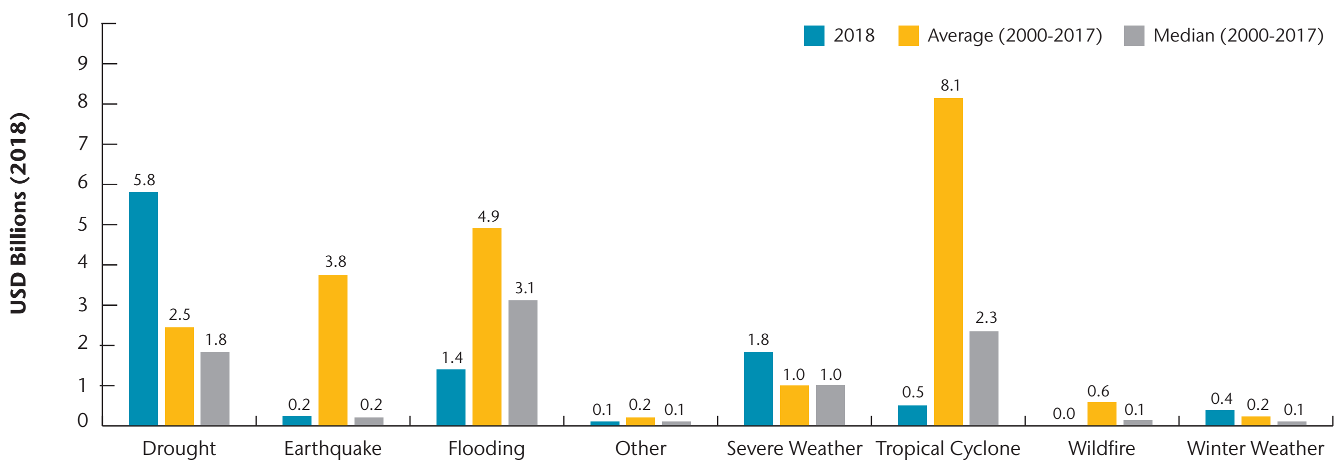


Exhibit 49: Americas (Non-U.S.) Economic and Insured Losses (Weather Only)



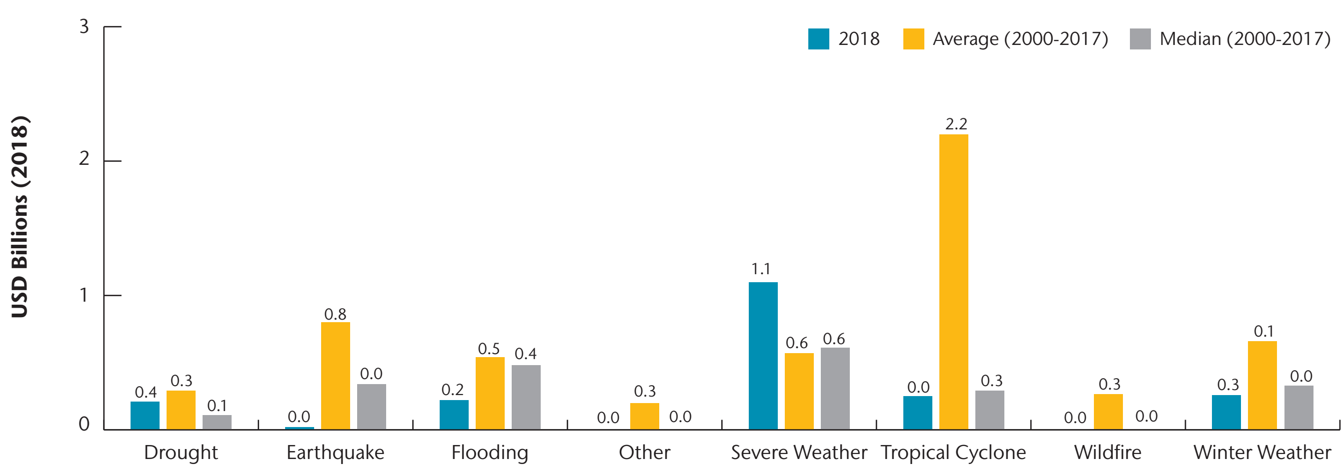
Overall economic losses in the Americas (Non-U.S.) were 50 percent lower than the 2000-2017 average – skewed by catastrophic loss years in 2010 and 2017 – and 13 percent lower than the median. The USD10 billion in the Americas was a substantial drop from the historic USD144 billion registered in 2017. The costliest peril of 2018 for the region was drought at more than USD5.8 billion. This was primarily driven by significant drought events in South and parts of Central. It was the only peril which led to a multi-billion-dollar loss. Severe weather (thunderstorm) was second-costliest, with much of the costs incurred in Canada.

Exhibit 50: Americas (Non-U.S.) Economic Losses by Peril



The industry's most expensive peril during 2018 in the Americas (Non-U.S.) was severe weather. A major portion of the cost was directly tied to a series of thunderstorm outbreaks (resulting in damage from either straight-line winds, hail, or tornadoes) in Canada. Winter weather and drought were the only other perils with above average and median payouts.

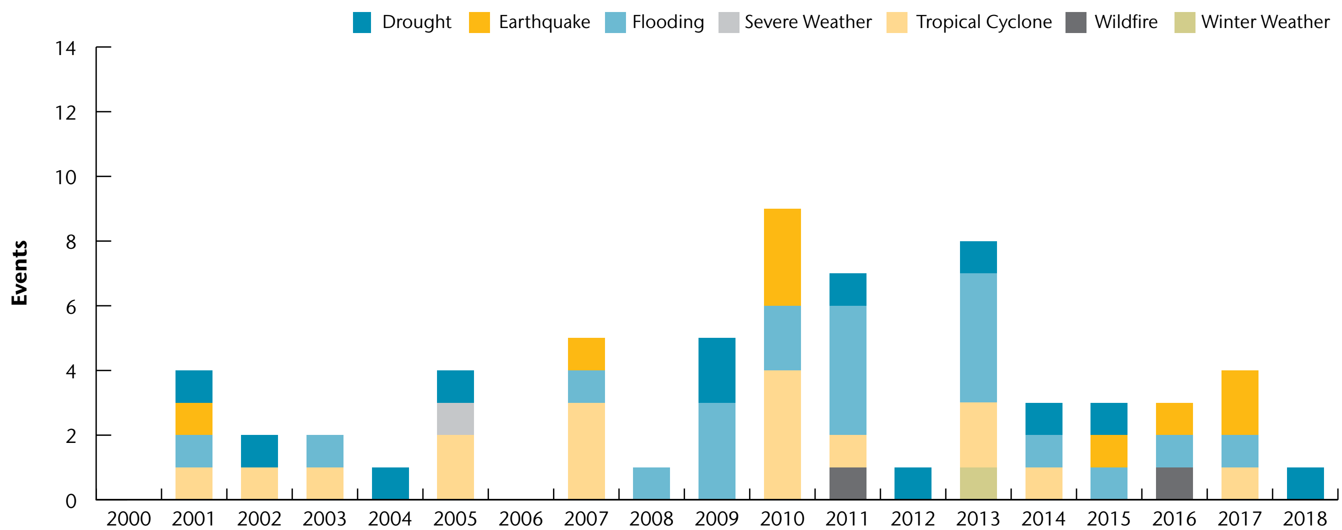
Exhibit 51: Americas (Non-U.S.) Insured Losses by Peril



Please note that insured losses include those sustained by private insurers and government-sponsored programs.

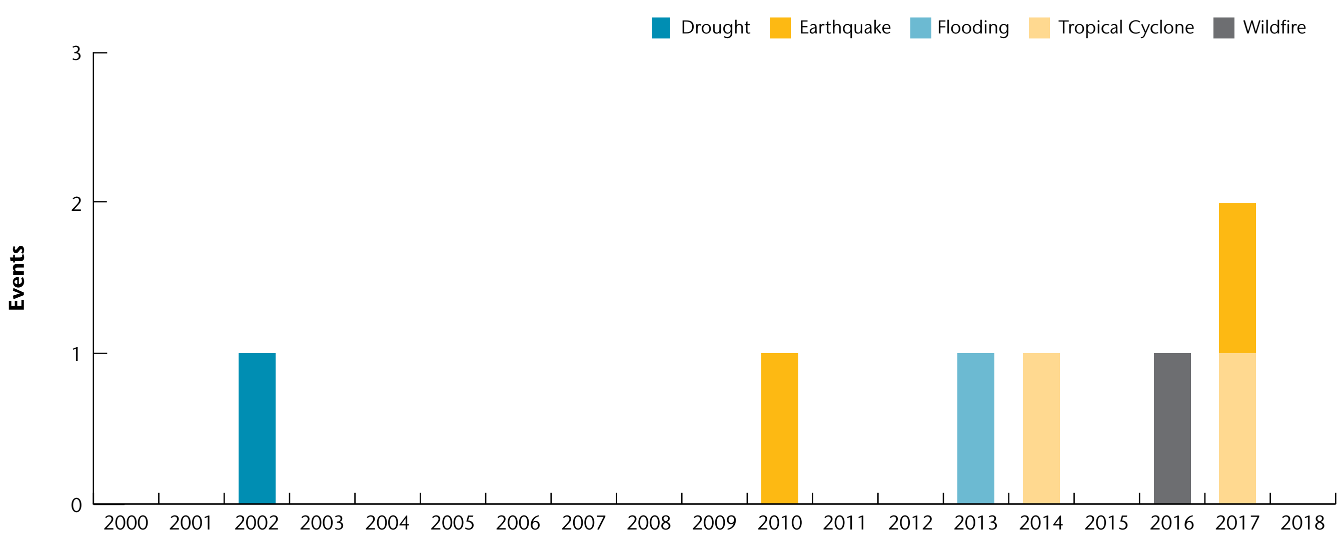
There was only one natural disaster in the Americas (Non-U.S.) that caused at least USD1 billion in economic losses in 2018. It was a severe drought that impacted Argentina. This is lower than the typical annual average of two. This was the first year without a billion-dollar earthquake event in the Americas since 2014.

Exhibit 52: Americas (Non-U.S.) Billion-Dollar Economic Loss Events



For the first time since 2015, there were no individual billion-dollar events for the insurance industry in the Americas (Non-U.S.). The region typically averages such an event once every two or three years. 2017 featured the most (five) on record for the basin. The primary reason for the lower volume of events is a combination of lower levels of insurance penetration and a lack of available industry data in Latin America.

Exhibit 53: Americas (Non-U.S.) Billion-Dollar Insured Loss Events



Virgin Islands Port Authority Began 2018 Hurricane Season Prepared For The Worst

Peter Jagger, *Aon*

The Virgin Islands Port Authority (VIPA) began the 2018 Atlantic Hurricane Season well prepared for the onslaught of potential storms, given lessons learned from its unprecedented experience the prior year.

In September 2017, the US Virgin Islands (USVI) was struck by two Category 5 hurricanes (Irma and Maria) within two weeks. At that time, its recovery depended on how quickly its severely damaged airports, seaports and harbors could be restored.

These facilities – among 119 throughout USVI operated by VIPA – are the only means of ingress or egress for the Islands. They are critical for deliveries of food, clothing, medical equipment, fuel, necessities, and tourism, which accounts for 80 percent of USVI's GDP.

Fortunately, VIPA was prepared. Its leadership, outsourced risk manager, Alpha Risk Management Inc., and Aon, VIPA's insurance broker, collaborated for years on measures to elevate VIPA's hurricane protection and preparedness, including: updated property and equipment appraisals of all 119 facilities; property insurance coverage enhancements and increases in VIPA's limits for windstorm/hurricane and flood; establishment of business continuity and crisis management plans; and engagement of trusted claims consultants to work on their behalf with adjusters/insurers following a loss event.

These initiatives – along with effective disaster response, damage mitigation and claim management – were keys to VIPA's accelerated recovery, including: advance insurance payments; airport repairs and restoration of airline service; major seaport repairs; and subsequent renewal of VIPA's property insurance program.

VIPA's ongoing recovery has been key to restoring USVI's economy, infrastructure, and commercial and residential recoveries. Lessons from VIPA's experience include:

- Prepare for a worst-case scenario. Few anticipated two major storms striking the same islands within weeks; VIPA is now reassessing its earthquake/seismic risks and related planning.
- Have up-to-date appraisals, documentation and photographs of key assets. All proved critical to VIPA's insurance recovery.
- Double-check insurance well in advance of any event. VIPA increased its coverage for windstorm/hurricane and flood years before the 2017 hurricanes.
- Update comprehensive disaster/business continuity plans. Develop protocols to protect employees, customers, facilities, and equipment, mitigate loss and facilitate recovery.
- Review disaster communication. Access to internet communication and satellite phones may be vital.
- Alert insurers of pending loss. VIPA notified its carriers before the first hurricane made landfall.
- Consider early warning systems. Aon's Rapid Response helped VIPA assess storm paths and pinpoint at-risk properties.
- Recognize a fast response can help accelerate recovery. VIPA team members quickly visited properties, took photographs and conducted initial damage assessments.
- Understand the role of emergency responders and government agencies. FEMA, the FAA, DOT, MARAD and the U.S. Coast Guard provided timely assistance and support to VIPA.

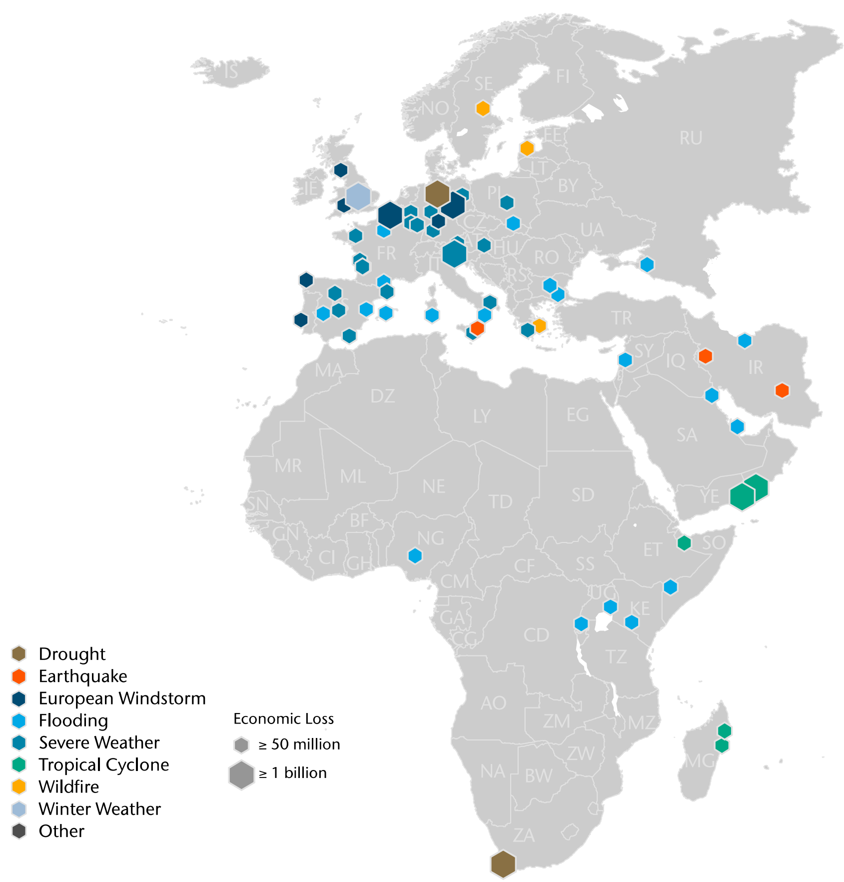
Europe, Middle East & Africa (EMEA)

Exhibit 54: Top 5 Most Significant Events in EMEA

Date(s)	Event	Location	Deaths	Economic Loss (USD)[13]	Insured Loss (USD)[13,14]
Spring & Summer	Drought	Central & Northern Europe	N/A	9.0 billion	300 million
Oct 28 – Nov 3	Storms & Flooding	Italy, Austria	29	5.0 billion	715 million
January 18	Windstorm Friederike	Western & Central Europe	13	2.5 billion	2.1 billion
Feb 23 – Mar 3	Winter Weather	Western & Central Europe	95	1.6 billion	700 million
January 3	Cyclone Mekunu	Oman	31	1.5 billion	400 million
		All Other Events	~1,300	~14.4 billion	~6.0 billion
		Totals	**~1,500**	**~34 billion[1]**	**~10 billion[1,2]**

[1] Subject to change as loss estimates are further developed
[2] Includes losses sustained by private insurers and government-sponsored programs

Exhibit 55: Significant 2018 Economic Loss Events[1]



[1] Based on events that incurred economic loss greater than USD50 million. Position of an event is determined by the most affected administrative unit or epicenter.

Overall economic losses that were caused by natural catastrophes in Europe, Middle East, and Africa in 2018 were comparable to their long-term normal values. Total aggregated losses were preliminarily estimated at more than USD33.5 billion, which is 1.3 percent above the average of years 2000-2017 on an inflation-adjusted basis. Comparing the data with more recent, 10-year average, economic loss total was 4.7 percent lower. Comparison of the totals with medians of the same periods indicates a downturn of 10 percent or an increase of 9 percent on the shorter timeframe, respectively.

However, 2018 was marked by a lack of financially significant earthquakes, with the peril incurring less than one percent of the total economic loss in EMEA in 2018. Focusing solely on weather and climate related costs, EMEA saw significantly increased disaster losses compared to normal; approximately 15 percent above both the 10-year and 18-year averages and 27, or 30 percent above medians of the respective periods.

Insurers in EMEA recorded aggregated losses of USD10.3 billion, which was 14.6 percent above the long-term average since 2000. Comparing the total with the median value suggests even higher increase of 25.2 percent. If only the last 10 years are considered, insured losses showed a 10-percent uptick against the average value and 25 percent against the median.

European windstorm generated the two costliest events for insurers in Europe. Despite a relative lack of other events, January's Windstorms Friederike and Eleanor alone accounted for more than 28 percent of the total annual insured loss in EMEA. Friederike, with main impacts located throughout Germany and the Netherlands, became the costliest storm since Xynthia in 2010. However, insurers across the region faced higher aggregated payouts from summer storms. Widespread thunderstorm activity in the spring and summer months resulted in insured losses of approximately USD4.5 billion, or nearly 44 percent of the annual total for the region.

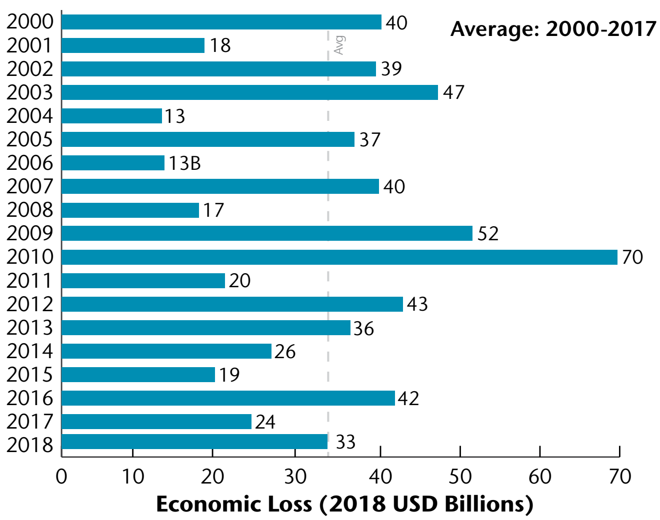
In May, Oman was hit by a powerful Cyclone Mekunu, which resulted in insured losses of more than USD400 million.

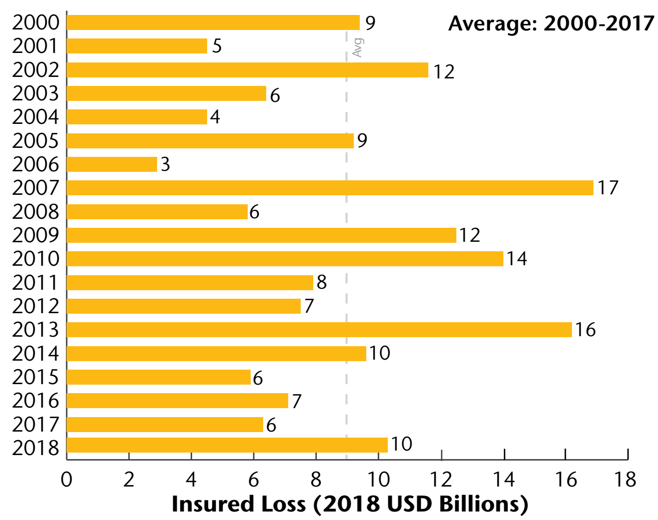
A substantial part of the total economic loss in EMEA was attributed to drought. Prolonged lack of precipitation and abnormally high temperatures during spring and summer months resulted in notable reductions in expected harvest and prompted European farmers to anticipate significant losses, which amounted to nearly USD9.0 billion. These totals are the highest since the catastrophic summer of 2003, which was estimated to have caused agricultural losses of approximately USD21.9 billion (inflated to 2018 values). Additional notable drought in 2018 was also observed in South Africa. Despite elevated economic losses, insurance payouts due to drought remain relatively low. This highlights a problem of crop underinsurance in many developed countries.

Despite persistent drought conditions, extent of land burned by forest fires in European was at its lowest since at least 1980. Nevertheless, several countries recorded notable events, namely Sweden, Germany and Latvia. July's wildfire in Attika, Greece caused 99 fatalities and became the deadliest single European wildfire event in recorded history.

Economic loss totals in EMEA in 2018 were comparable to the average of 2000 -2017 (USD33 billion) and above the long-term normal since 1980 on an inflation-adjusted basis (USD30 billion). From the insurance sector perspective, 2018 can be described as an above-normal year with aggregated total being 14.6 percent or 30 percent higher than the average since 2000, or 1980, respectively.

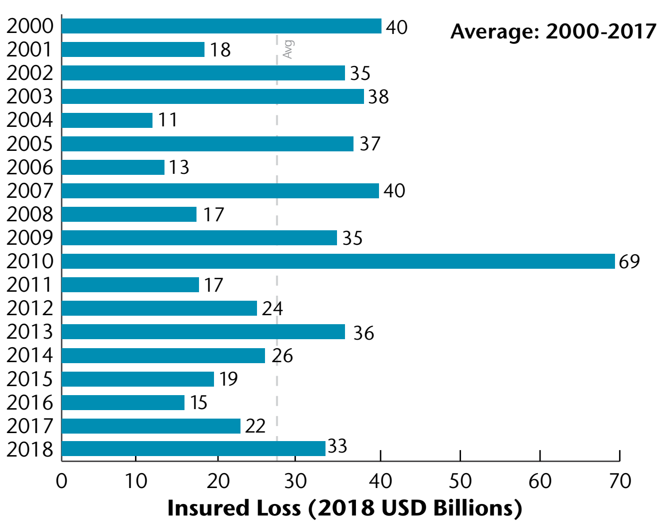
Exhibit 56: EMEA Economic and Insured Losses (All Natural Disasters)

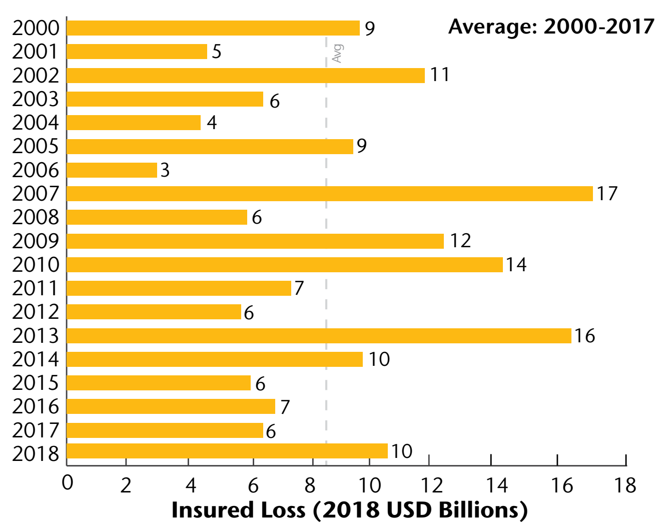




Focusing solely on weather-related disasters, 2018 loss totals were above long-term averages and medians and the year was the costliest since 2013 on economic loss basis. Insured losses were at 117 percent of their 18-year averages.

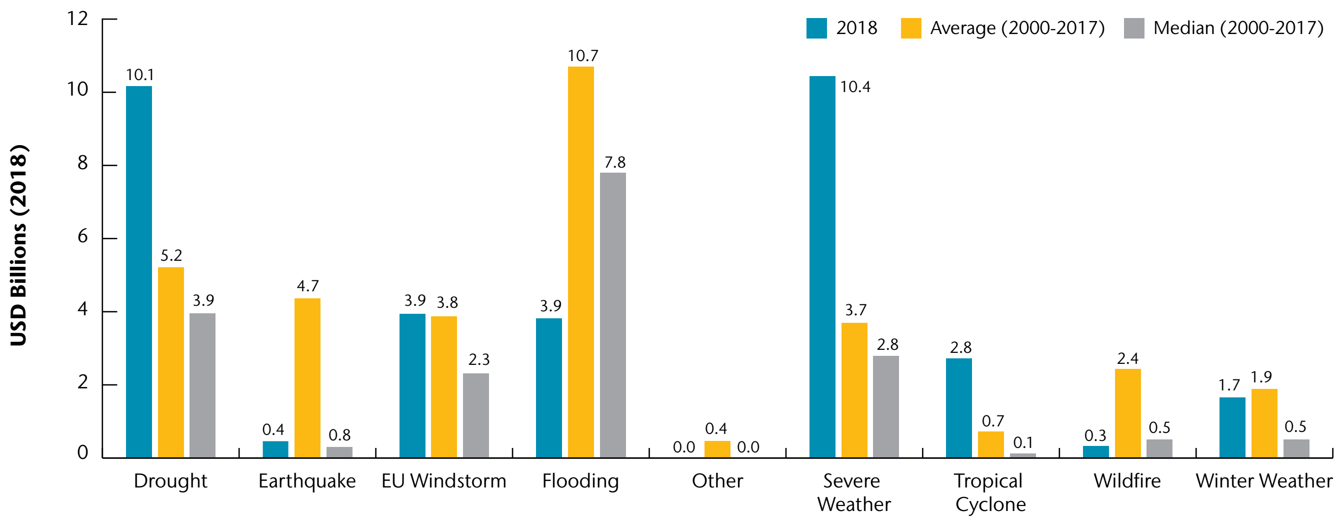
Exhibit 57: EMEA Economic and Insured Losses (Weather Only)





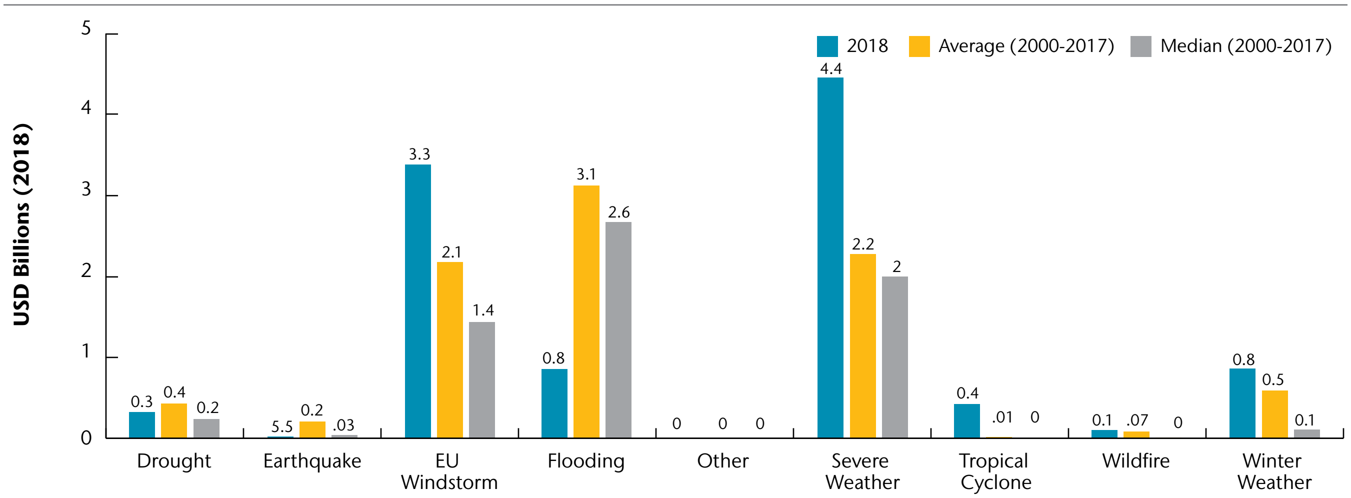
2018 was marked by notable droughts, which brought the economic losses related to the peril above USD10 billion mark for only the fourth time in history. Earthquake, flooding and wildfire perils did not exceed their long-term norms. On the other hand, 2018 saw elevated losses from European windstorms, severe weather and tropical cyclones in the Indian Ocean.

Exhibit 58: EMEA Economic Losses by Peril



Insured losses from European windstorms, severe weather and tropical cyclones were above their long-term normal values. Windstorms accounted for nearly 33 percent of the total. The peril thus remains historically the most expensive for the region, being responsible for approximately 43 percent of all insurance losses accumulated since 1980 on an inflation-adjusted basis.

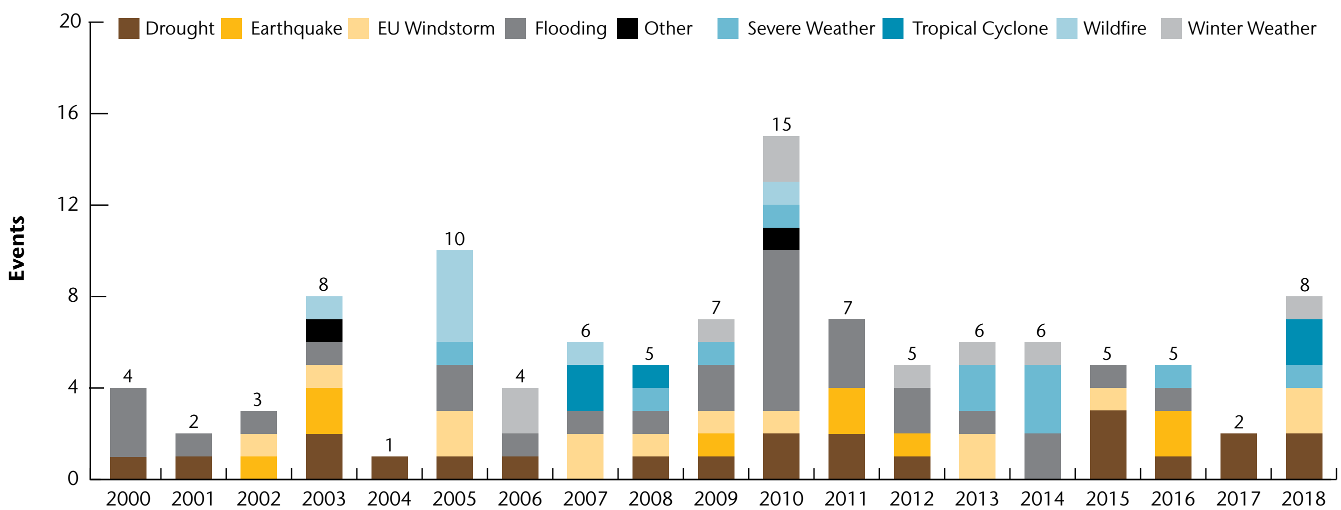
Exhibit 59: EMEA Insured Losses by Peril



Please note that insured losses include those sustained by private insurers and government-sponsored programs.

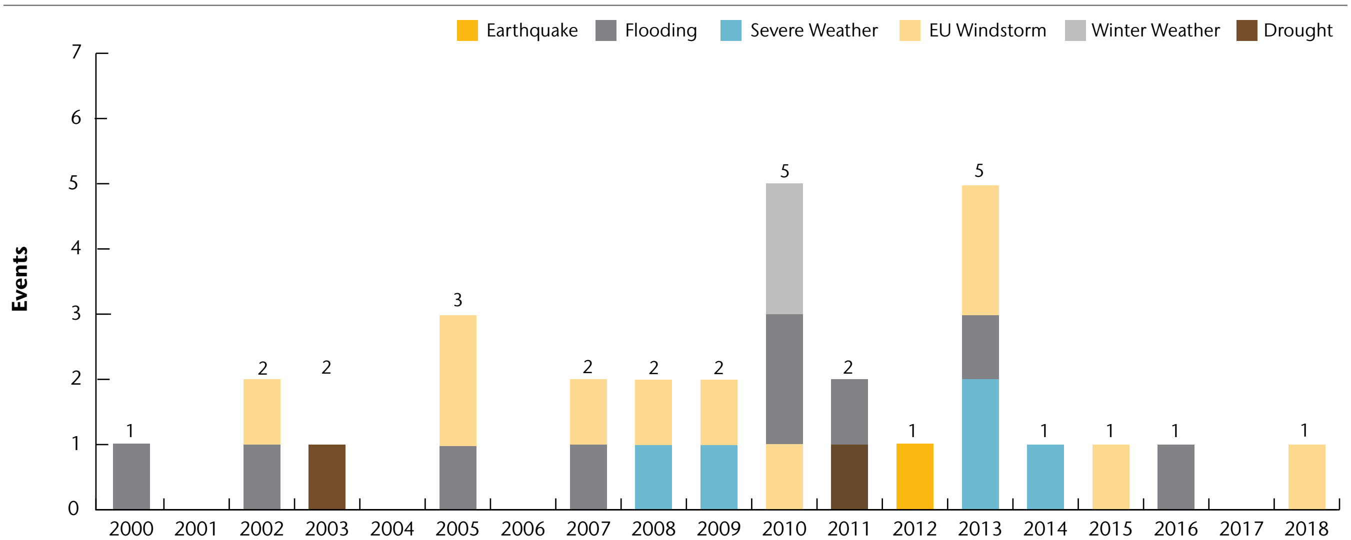
There were eight billion-dollar event in EMEA region in 2018 from the economic perspective, the highest number since 2010. There were two notable droughts in Europe and South Africa. Windstorms Friederike and Eleanor both exceeded the billion-dollar mark. 2018 also saw two costly cyclones – Mekunu and Luban, which impacted the Arabian Peninsula. The remaining events were severe weather outbreak in Italy and winter weather in Europe.

Exhibit 60: EMEA Billion-Dollar Economic Loss Events



On the other hand, there was only one event that caused more than 1 billion of insured losses: Windstorm Friederike in January resulted in payouts of approximately USD2.1 billion.

Exhibit 61: EMEA Billion-Dollar Insured Loss Events



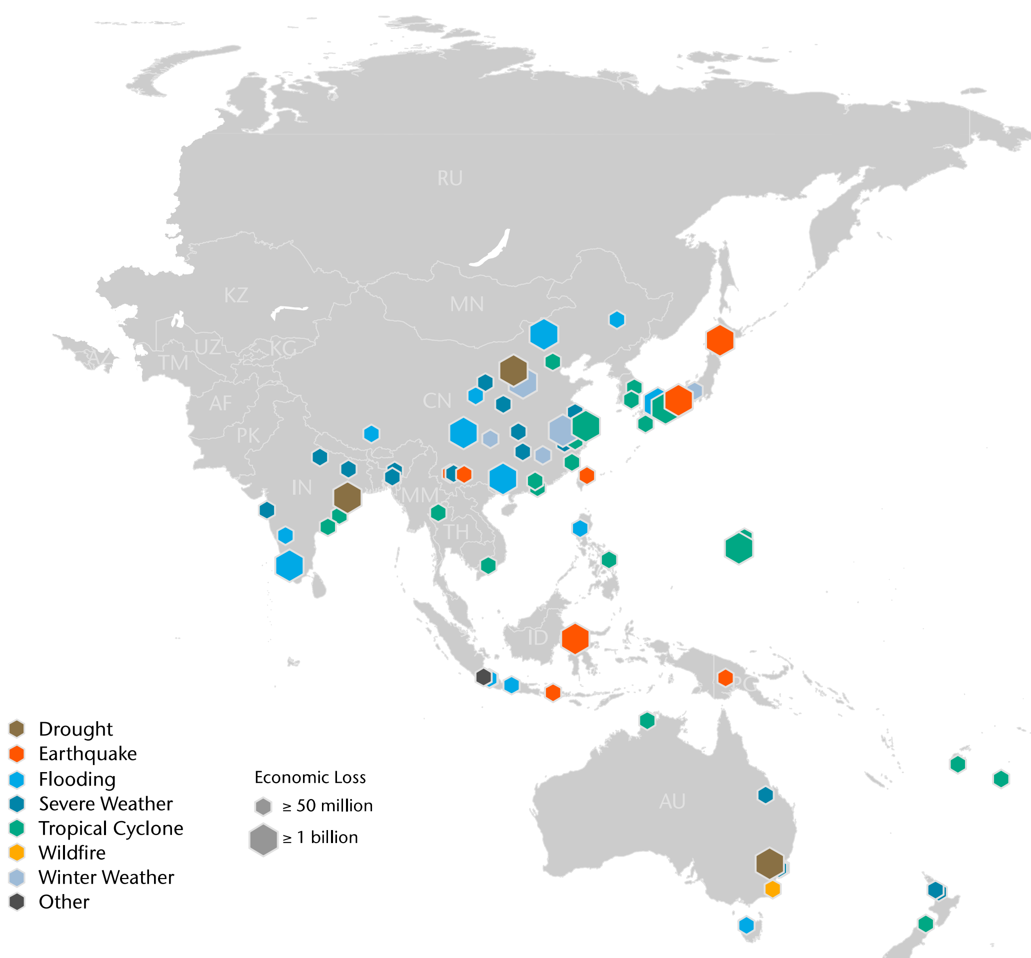
Asia & Oceania (APAC)

Exhibit 62: Top 5 Most Significant Events in APAC

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
Sept 4 – 5	Typhoon Jebi	Japan	17	13 billion	8.5 billion
Jul 2 – Jul 8	Japan Floods	Japan	246	10 billion	2.7 billion
Sept 28 – Oct 1	Typhoon Mangkhut	Oceania, Philippines, China	161	6 billion	1.3 billion
June - August	Monsoonal Flooding	India	1,424	5.1 billion	300 million
December 20	Severe Weather	Australia	0	875 million	700 million
		All Other Events	~7,315	~54 billion	~7.3 billion
		Totals	**~8,100**	**~89 billion[1]**	**~21 billion[1,2]**

[1] Subject to change as loss estimates are further developed
[2] Includes losses sustained by private insurers and government-sponsored programs

Exhibit 63: Significant 2018 Economic Loss Events[1]



[1] Based on events that incurred economic loss greater than USD50 million. Position of an event is determined by the most affected administrative unit or epicenter.

Asia Pacific had a largely expected year in terms of the occurrence of natural catastrophes with 144 separate events causing at least 10 deaths and/or USD50 million economic loss and/or USD25 million insured loss – 5 percent more than the average number of disasters since 2000. The region suffered economic losses of over USD89 billion on 2018 due to natural disasters. This was slightly higher than the 21st century average (USD87 billion) and over 50 percent higher than the median loss since 2000-2017 (USD58 billion).

The overall insured loss (USD21 billion) for APAC was nearly 91 percent higher than the average insured loss for 2000-2017 (USD11 billion) and nearly 300 percent higher than the median loss (USD5 billion). The elevated insurance losses were predominantly driven by several high-loss events in Japan where the insurance penetration is significantly higher than much of the rest of the region. In the 21st century, the insured losses incurred in the present year were second to only to that of 2011 (USD80 billion).

The top three most expensive events of 2018, in terms of economic as well insured loss, all occurred in Japan. At the beginning of September, Typhoon Jebi prompted a USD13 billion economic loss and USD8.5 billion in insurance payouts. Typhoon Trami made landfall in Japan at the end of September causing an estimated economic loss of USD4.5 billion with insurance payouts reaching USD2.6 billion at the time of this report. In July, the remnants of Typhoon Prapiroon intensified the Mei-Yu rains causing widespread flooding in Japan. Economic loss due to the event reached UD10 billion with USD2.65 billion of that covered by insurance.

September was the most expensive month in terms of catastrophe losses in APAC with another notable cyclone, Typhoon Mangkhut, striking Guam, Northern Mariana Islands, Philippines, China and Hong Kong. Mangkhut caused USD6 billion in economic losses and USD1.3 billion in insured losses.

Apart from the Japan floods, two other significant events in 2018 were the Northern China floods between July and November and monsoonal flooding in Kerala, India between June and August. each of which prompted economic losses of over USD5.7 billion. The Northern China floods prompted economic loss of over USD5.7 billion while the economic loss due to the Kerala floods exceeded USD4.4 billion.

There were three significant droughts in the Asia Pacific in 2018. A year-long drought caused over USD1 billion in losses in New South Wales and Queensland, with the whole of New South Wales being declared drought-hit by August, marking this the most severe and widespread drought in the region since 1981-1982. Parts of China and India also suffered from drought with estimated crop loss of over USD3.5 billion in each case.

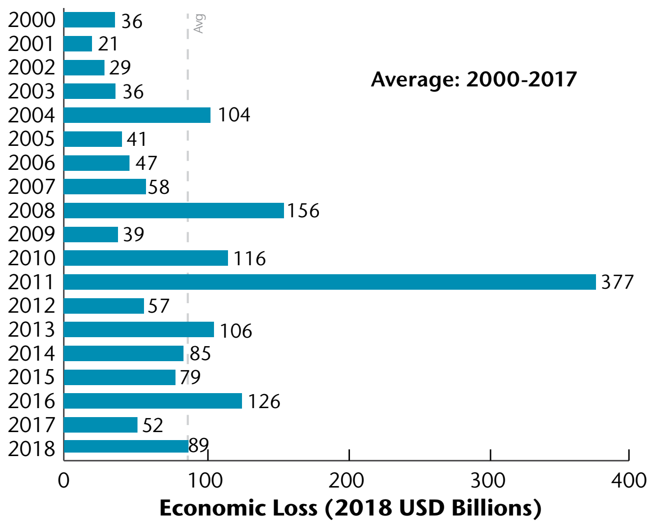
The Asia Pacific had nearly 50 percent more noteworthy severe weather events (31) in 2018 than the 21st century average (21). A December hailstorm event in Sydney and elsewhere in New South Wales prompted a declaration of catastrophe by the Australian Insurance Council and caused insured losses of at least USD700 million. A similar hailstorm in the April of 1999 triggered economic losses of USD2.3 billion and insured losses approaching USD1.7 billion in today's dollars. Elsewhere, in India, a series of pre-monsoon storms killed over 450 people between April-June, making it one of the deadliest seasons in the 21st century for the country.

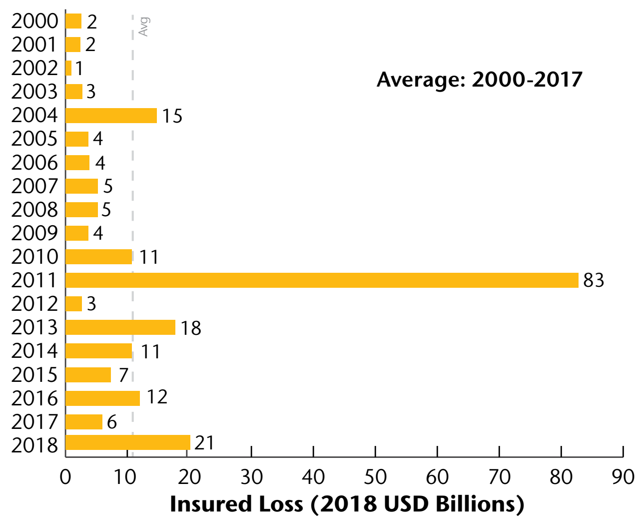
The deadliest events of 2018 all occurred in Indonesia. In September, an M7.5 earthquake that occurred in Indonesia in September which a tsunami and resulted in 2,256 deaths and an economic loss of USD1.45 billion. In August, the Lombok Earthquake which killed 560 people in the country. On December 22, eruptions from the Anak Krakatoa Volcano triggered underwater landslides and a tsunami that killed at least 437 people. Other high death toll events elsewhere included monsoon floods across India between June and September which caused 1,424 deaths and the Japan floods in July, which killed 246 people.

Both economic and insured losses from natural disasters and weather-only events (excluding earthquakes, volcanoes and tsunami) have shown positive annual rates of growth since 2000 in the Asia Pacific. With rapid population and exposure growth in some of the world's most vulnerable areas, higher economic loss events are expected to increase in the coming years.

Economic loss totals in APAC in 2018 were comparable to the 21st century average (USD87 billion) and higher than a long-term normal since 1980 on an inflation-adjusted basis (USD63 billion). In terms of insured loss, 2018 was well above-normal with payouts exceeding the 21st century average by almost 91 percent and the median by 296 percent. It marked the second highest year for the industry since 2000; only behind 2011 (USD83 billion).

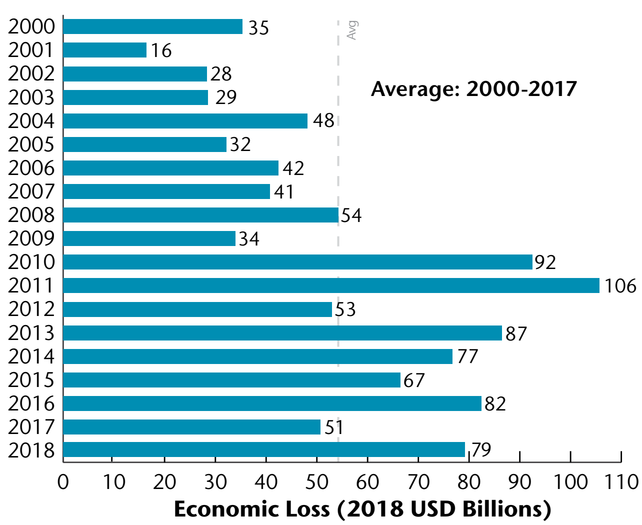
Exhibit 64: APAC Economic and Insured Losses (All Natural Disasters)

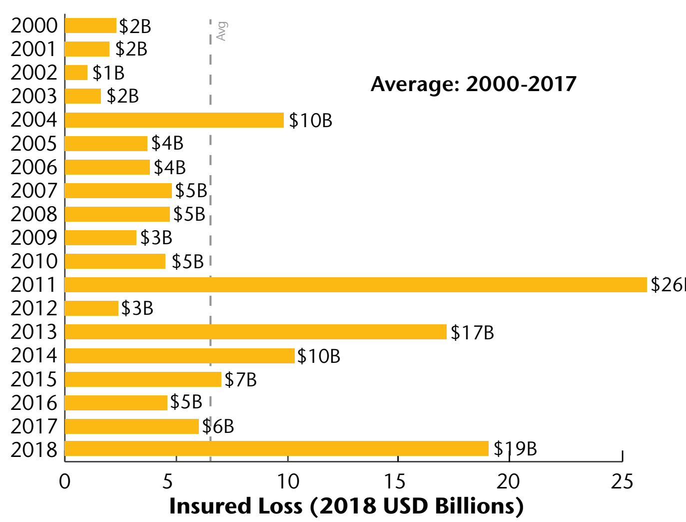




Economic losses incurred only due to weather-related disasters (USD79 billion) were about 46.7 percent higher than the 21st century average of USD54 billion and almost 60 percent higher than the median loss of USD59.8 billion. Insurance payouts from weather-related losses in 2018 (USD19.2 billion) were 200 percent higher than the 2000-2017 average (USD6.4 billion) and nearly 320 percent of higher than the median (USD4.6 billion).

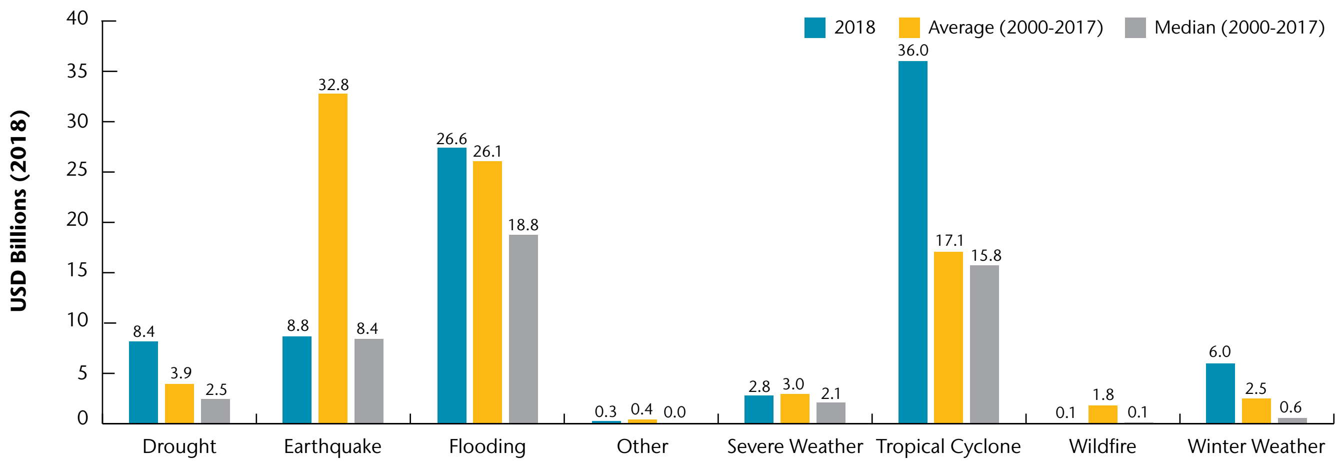
Exhibit 65: APAC Economic and Insured Losses (Weather Only)





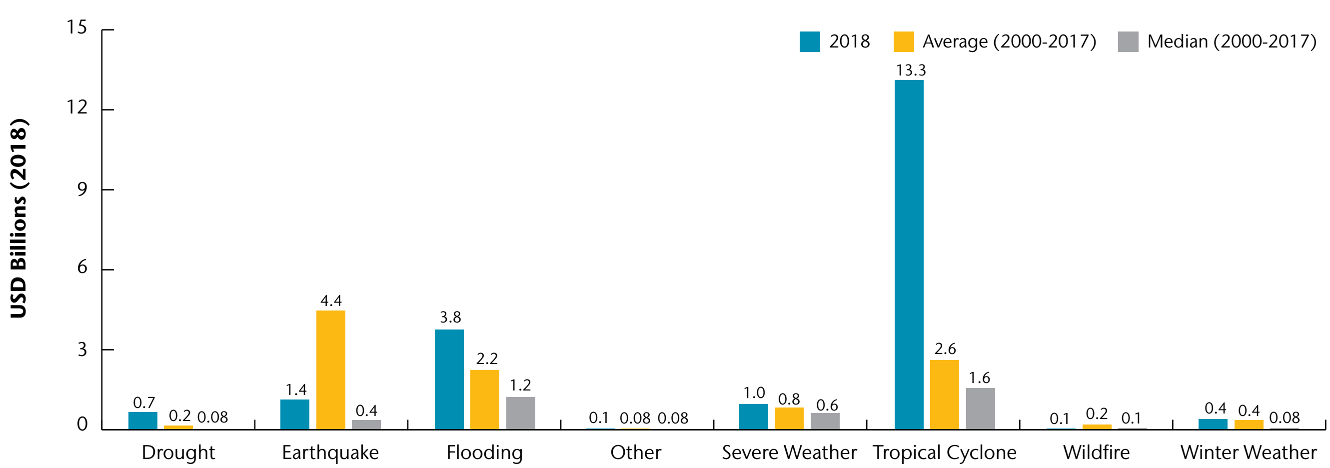
The main drivers of economic loss in 2018 were tropical cyclones followed by flooding and drought. Losses due to tropical cyclones far exceeded the long-term average. Losses due to droughts, and winter weather were also higher than the 2000-2017 average. Economic losses from earthquakes, severe weather, and wildfire were lower than the long-term average.

Exhibit 66: APAC Economic Losses by Peril



Insurance payouts in 2018 were overall higher than normal. A number of expensive tropical cyclones, particularly Jebi, Trami and Mangkhut caused payouts from public and private insurers to exceed USD13 billion, much higher than the 2000-2017 average of USD2.6 billion and median of USD1.5 billion.

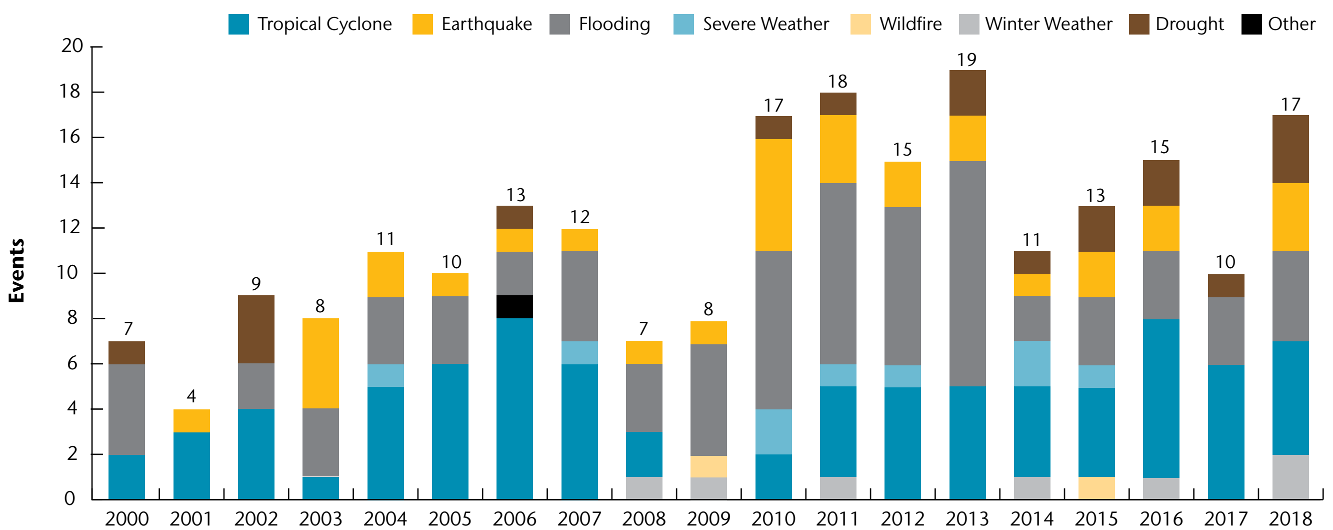
Exhibit 67: APAC Insured Losses by Peril



Please note that insured losses include those sustained by private insurers and government-sponsored programs.

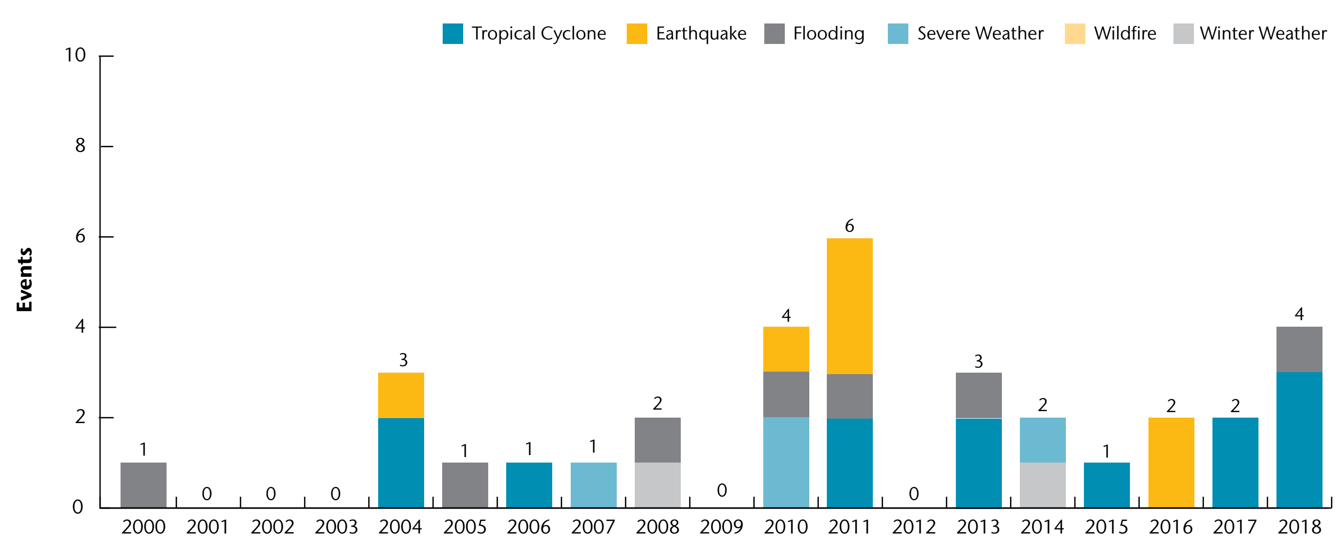
There were at least 17 separate events that triggered economic losses of USD1 billion or higher in 2018. This was higher than the 18-year average of 12 and second only in this century to 2011 where 19 billion-dollar events occurred in APAC. At least five separate floods (three in China and one each in India and Japan) and four tropical cyclones (Jebi, Trami, Mangkhut, and Rumbia) caused economic losses of over USD1 billion each. Two separate episodes of winter weather caused billion-dollar losses to agriculture in China. Significant losses to agriculture were also caused by at least three significant droughts in Australia, China, and India. Apart from the billion-dollar weather events, there was an earthquake and associated tsunami in Indonesia and two earthquakes in Japan that caused billion-dollar economic losses.

Exhibit 68: APAC Billion-Dollar Economic Loss Events



In 2018, there were at least four separate events that prompted billion-dollar insurance payouts – the highest alongside 2004 since 2011 which had 7 billion-dollar payouts. For the first time in APAC, there were three tropical cyclones that prompted billion-dollar insurance payouts in a single year.

Exhibit 69: APAC Billion-Dollar Insured Loss Events



Concluding Remarks

2018 was another active year for global natural disasters. While there was not a singular "mega" event which prompted individual damage costs beyond USD25 billion on an economic basis, nor above USD15 billion for the insurance industry, there were several moderately large events which aggregated to become quite costly. Despite the significance of the losses, the re/insurance industry remains flush with available capital to handle the high volume of payouts. Given the nearly USD600 billion in capital that currently exists, it would likely require a substantial-sized event or two in a single year to lead to any sizable shift in the overall insurance market.

What is already shifting is the view of individual perils and their associated risks. This was most notable in 2018 with the wildfire peril. Given back-to-back years (2017 and 2018) with considerable losses for the industry, it is changing how insurance, government, and other sectors view wildfire potential on an annual basis. With continued shifts in population patterns into known fire locations, elongated fire seasons, evolving fire behavior, and further weather pattern enhancements from climate change, this raises the profile of identifying sufficient mitigation and resiliency measures to reduce the risk. While wildfire is the provided example in this instance, there are similar conversations being had with every peril in every region of the world.

How this Report Can Help

The annual "Weather, Climate, and Catastrophe Insight" report is meant to be digested by many different sectors. We hope that the wealth of qualitative and quantitative information in this main document, and the accompanying companion report, will be absorbed and utilized by the insurance industry, government agencies, risk managers, emergency management, climate science, academia, and other sectors to better understand and put into context the increasingly volatile world of natural disasters.

Some takeaways from this report include:

- Identification of catastrophe loss trends on a global and regional scale
- Data-driven analysis highlighting vulnerable locales from specific perils
- Modernizing and implementing stringent building code requirements
- Developing public and private risk mitigation solutions to reduce vulnerabilities
- Introduce insurance strategies to close the global protection gap
- Climate change influence more identifiable as extreme weather events impact greater exposure centers
- Communication of risk and uncertainty remains a challenging, yet vital component of resilience planning

Appendix A: 2018 Global Disasters

Exhibit 70: United States

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-12/31	Drought	Nationwide	N/A	N/A	3.2+ billion
01/03-01/05	Winter Weather	Eastern & Central U.S.	22	60,000+	1.1+ billion
01/08-01/09	Flooding	California	21	6,500+	900+ million
01/14-01/17	Winter Weather	Plains, Midwest, Northeast, Southeast	16	10,000+	100+ million
01/21-01/24	Winter Weather	Plains, Midwest	10	10,000+	50+ million
02/03-02/07	Winter Weather	Plains, Midwest, Northeast	7	7,500+	50+ million
02/07-02/10	Winter Weather	Plains, Midwest, Northeast	5	5,000+	50+ million
02/19-02/22	Flooding	Plains, Midwest, Southeast	10	25,000+	400+ million
02/23-02/27	Severe Weather	Plains, Midwest, Southeast	5	15,000+	175+ million
03/01-03/03	Winter Weather	Northeast	9	325,000+	2.3+ billion
03/07-03/08	Winter Weather	Northeast	1	62,000+	525+ million
03/12-03/15	Winter Weather	Northeast	0	5,000+	75+ million
03/18-03/21	Severe Weather	Plains, Southeast, Northeast	0	102,500+	1.5+ billion
03/21-03/22	Flooding	California	0	Hundreds	Millions
04/03-04/04	Severe Weather	Plains, Midwest, Southeast	1	40,000+	335+ million
04/06-04/07	Severe Weather	Texas, Louisiana, Mississippi	0	80,000+	900+ million
04/07	Severe Weather	Idaho	0	12,500+	135+ million
04/13-04/17	Severe Weather	Plains, Midwest, Southeast, Northeast	4	115,000+	1.4+ billion
04/14-04/15	Flooding	Hawaii	0	5,000+	125+ million
04/17-04/18	Severe Weather	Rockies, Plains	0	20,000+	150+ million
04/22-04/23	Severe Weather	Southeast	0	5,000+	30+ million
04/28-05/05	Severe Weather	Plains, Midwest	0	125,000+	1.4+ billion
05/03-07/30	Volcano	Hawaii	0	1,000+	500+ million
05/12-05/16	Severe Weather	Rockies, Plains, Midwest, Northeast	5	115,000+	1.45+ billion
05/19-05/20	Severe Weather	Plains, Midwest	0	30,000+	540+ million
05/28-06/01	Severe Weather	Rockies, Plains, Midwest, Mid-Atlantic	1	45,000+	600+ million
05/27-05/28	Flooding	Maryland	1	5,000+	100+ million
05/27-05/30	Tropical Storm Alberto	Southeast, Midwest	5	10,000+	125+ million
06/03-06/07	Severe Weather	Plains, Midwest, Southeast	0	105,000+	1.3+ billion
06/11-06/13	Severe Weather	Rockies, Plains	0	60,000+	980+ million
06/13-06/14	Severe Weather	Northeast	0	5,000+	75+ million
06/17-06/21	Severe Weather	Rockies, Plains, Midwest	3	190,000+	2.3+ billion
06/19-06/21	Flooding	Texas	0	15,000+	225+ million
06/23-06/26	Severe Weather	Central/Eastern U.S.	0	20,000+	195+ million
06/27-06/29	Severe Weather	Plains, Midwest, Southeast	1	15,000+	150+ million
06/29-07/04	Severe Weather	Plains, Midwest	1	22,000+	250+ million
06/01-07/31	Wildfire	Western U.S. (Spring Creek Fire; CO).	1	10,000+	500+ million

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
07/08-07/10	Severe Weather	Arizona	0	15,000+	200+ million
07/19-07/22	Severe Weather	Plains, Midwest, Southeast	18	90,000+	1.5+ billion
07/21-07/26	Flooding	Northeast, Mid-Atlantic, Southeast	1	30,000+	450+ million
07/22-07/24	Severe Weather	Colorado	0	12,500+	150+ million
07/26-07/29	Severe Weather	Rockies, Plains, Southwest	0	65,000+	890+ million
07/30-07/31	Severe Weather	Southwest	0	25,000	250,000+ million
07/24-08/31	Wildfire	California (Mendocino)	1	6,000+	350+ million
08/01-08/31	Wildfire	California (Carr)	8	12,000+	1.8+ billion
08/06-08/08	Severe Weather	Rockies, Plains	0	70,000+	1+ billion
08/11-08/15	Flooding	Northeast, Mid-Atlantic	0	15,000+	450+ million
08/14-08/16	Severe Weather	Oklahoma, Texas	0	5,000+	50+ million
08/20	Flooding	Wisconsin	0	10,000+	350+ million
08/22-08/26	Hurricane Lane	Hawaii	1	3,000+	250+ million
08/27-08/29	Severe Weather	Midwest	0	35,000+	725+ million
09/04-09/09	Tropical Storm Gordon	Southeast	2	15,000+	250+ million
09/12	Hurricane Olivia	Hawaii	0	2,000+	25+ million
09/14-09/19	Hurricane Florence	Southeast, Mid-Atlantic	53	400,000+	15+ billion
09/20-09/21	Severe Weather	Midwest	0	13,000+	200+ million
09/21-09/24	Severe Weather	Plains, Southeast	2	13,000+	250+ million
09/24-09/26	Severe Weather	Midwest, Northeast	1	10,000+	250+ million
10/01-10/03	Flooding	Arizona, New Mexico, California	3	2,000+	50+ million
10/02	Severe Weather	Northeast	0	5,000+	50+ million
10/10-10/12	Hurricane Michael	Southeast, Mid-Atlantic, Central America	45	350,000+	17+ billion
10/15-10/20	Flooding	Texas	2	20,000+	400+ million
10/31-11/01	Severe Weather	Plains, Southeast	2	10,000+	125+ million
11/05-11/06	Severe Weather	Southeast, Mid-Atlantic	1	10,000+	100+ million
11/08-11/21	Wildfire	California (Woolsey)	3	20,000+	5.75+ billion
11/08-11/25	Wildfire	California (Camp)	88	40,000+	15+ billion
11/14-11/16	Winter Weather	Northeast, Mid-Atlantic, Midwest	10	30,000+	250+ million
11/25-11/27	Winter Weather	Plains, Midwest, Northeast	2	10,000+	75+ million
11/29-11/30	Flooding	California	0	5,000+	100+ million
11/30	Earthquake	Alaska	0	15,000+	100+ million
11/30-12/02	Severe Weather	Plains, Midwest, Southeast	1	15,000+	150+ million
12/07-12/10	Winter Weather	Plains, Southeast, Mid-Atlantic	4	10,000+	240+ million
12/17-12/18	Severe Weather	West	0	2,500+	100+ million
12/20	Severe Weather	Southeast	0	7,500+	50+ million
12/26	Winter Weather	Plains, Midwest, Southeast	2	7,500+	150+ million

Exhibit 71: Remainder of North America (Canada, Mexico, Central America, Caribbean Islands)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/11-0/14	Flooding	Canada	0	5,000+	90+ million
02/16	Earthquake	Mexico	0	18,000+	Millions
02/19-02/22	Flooding	Canada	0	Thousands	75+ million
04/04-04/05	Winter Weather	Canada	0	15,000+	115+ million
04/14-04/17	Winter Weather	Canada	0	15,000+	295+ million
04/26-05/17	Flooding	Canada	0	Hundreds	10s of Millions
05/04-05/05	Severe Weather	Canada	3	70,000+	720+ million
05/26-05/29	Tropical Storm Alberto	Cuba	7	Thousands	Millions+
06/03	Volcano	Guatemala	122	Thousands	Millions
06/13	Severe Weather	Canada	0	Unknown	10s of Millions
06/14	Severe Weather	Canada	0	10,000+	110+ million
06/28-06/30	Severe Weather	Canada	0	Thousands	Millions
07/01-07/31	Drought	Central America	0	Unknown	200+ million
07/07-07/10	Severe Weather	Canada	0	4,000+	45+ million
07/09-07/11	Remnants of Beryl	Puerto Rico, Hispaniola	0	2,000+	Millions
07/13-07/14	Severe Weather	Canada	0	Thousands	Millions
08/02	Severe Weather	Canada	0	15,000+	100+ million
08/07-08/08	Flooding	Canada	0	4,500+	150+ million
09/05-09/07	Flooding	Mexico	3	2,500+	53+ million
09/20-09/23	Flooding	Mexico	20	300,000+	100s of millions
09/21	Severe Weather	Canada	0	15,000+	325+ million
10/06-10/07	Flooding	Central America	15	Thousands	100+ million
10/07	Earthquake	Haiti	18	20,000+	Millions
10/23	Hurricane Willa	Mexico	0	Hundreds	50+ million
10/23	Tropical Storm Vicente	Mexico	14	Unknown	Millions
11/01-11/04	Severe Weather	Canada	0	Thousands	10s of Millions

Exhibit 72: South America

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/14	Earthquake	Peru	2	2,541+	Millions
01/29-02/08	Flooding	Bolivia, Argentina	7	Thousands	138+ million
02/09	Severe Weather	Argentina	0	Thousands	Millions
02/15-02/21	Flooding	Brazil	4	Thousands	10s of Millions
01/01-03/31	Drought	Uruguay	N/A	N/A	500+ million
01/01-03/31	Drought	Argentina	N/A	N/A	3.4+ billion
03/20-03/21	Flooding	Brazil	3	Thousands	43+ million
03/12-04/17	Severe Weather	Colombia	14	Unknown	Millions
06/12	Severe Weather	Brazil	2	2,630+	Millions
10/19-10/24	Flooding	Trinidad & Tobago	0	4,300+	10s of millions
11/10	Landslide	Brazil	10	Hundreds	Negligible
11/12	Severe Weather	Chile	0	Thousands	200+ million
11/24	Landslide	Ecuador	9	Dozens	Negligible

Exhibit 73: Europe

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-01/04	WS Eleanor	Western & Central Europe	7	400,000+	1.1+ billion
01/06-01/07	Severe Weather	Spain	0	Thousands	100+ million
01/08	Earthquake	Netherlands	0	3,000+	Millions
01/18	WS Friederike	Western & Central Europe	13	1.25+ million	2.5+ billion
01/20-02/01	Flooding	France	0	30,000+	372+ million
02/23-03/02	Winter Weather	Western, Central & Eastern EU	95	Thousands	1.6+ billion
03/09-03/14	WS Felix & Gisele	Portugal, Spain	0	Hundreds	10s of Millions
03/25-04/05	Flooding	Greece, Turkey, Bulgaria	15	Thousands	Millions
04/01-04/30	Flooding	Spain	0	Thousands	64+ million
04/10-04/13	Severe Weather	Germany	0	Hundreds	68+ million
04/29	Severe Weather	Germany, France, Belgium	0	Thousands	10s of Millions
05/01	Winter Weather	Spain	0	Hundreds	10s of Millions
05/07-05/25	Severe Weather	Spain	0	Thousands	175+ million
05/10-05/16	Severe Weather	Central Europe	0	Thousands	10s of Millions
05/20-05/24	Severe Weather	Western & Central Europe	0	20,000+	100+ million
05/25-06/01	Severe Weather	Western & Central Europe	1	30,000+	675+ million
06/03-06/05	Severe Weather	Western & Central Europe	0	Thousands	140+ million
06/08-06/13	Severe Weather	Central, Western & SE Europe	6	Thousands	320+ million
06/21	Severe Weather	Poland, Austria	0	4,400+	50+ million
06/28-06/29	Flooding	Romania, Bulgaria, Ukraine	3	2,000+	125+ million
05/01-08/31	Drought	Northern & Central Europe	0	Unknown	9.0+ billion
07/03-07/05	Severe Weather	France, Germany, Italy	0	Thousands	200+ million

Exhibit 73: Europe (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
07/08-07/25	Wildfire	Sweden	0	Unknown	102+ million
07/15	Severe Weather	France, Germany, Austria	0	Hundreds	10s of Millions
07/15-07/22	Wildfire	Latvia	0	Hundreds	108+ million
07/18-07/19	Flooding	Poland, Slovakia	0	Hundreds	75+ million
07/23-07/24	Wildfire	Greece	99	1,657+	10s of millions
07/28	Severe Weather	Germany	0	Hundreds	Millions
08/20	Flooding	Italy	10	N/A	N/A
08/23-08/25	Severe Weather	Central Europe	0	Thousands	10s of Millions
09/19-09/22	Wind Storm Ali	Western & Northern Europe	2	Thousands	90+ million
09/23-09/24	Wind Storm Fabienne	Central Europe	1	Thousands	130+ million
09/24-09/27	Wind Storm Bronagh	Western & Northern Europe	2	Hundreds	10s of Millions
09/29	Severe Weather	Greece	2	2,000+	Millions
10/04-10/05	Flooding	Italy	3	Hundreds	200+ million
10/08-10/10	Flooding	Spain	13	5,500+	150+ million
10/11-10/11	Flooding	Italy	1	Hundreds	189+ million
10/12	Wind Storm Callum	United Kingdom	0	Hundreds	10s of Millions
10/12-10/15	Flooding	Norway	0	500+	10s of millions
10/13-10/14	Ex-Hurricane Leslie	Portugal, Spain	0	21,000+	120+ million
10/15-10/16	Flooding	France	15	35,000+	340+ million
10/17-10/21	Flooding	Spain	0	10,000+	100+ million
10/19-10/21	Severe Weather	Italy	0	Hundreds	Millions
10/23-10/24	Flooding	Russia	6	2,600+	10s of millions
10/28-11/04	Severe Weather	Italy, Austria	29	Thousands	5.0+ billion
11/15-11/20	Severe Weather	Spain	1	Hundreds	100+ million
12/26	Earthquake	Italy	0	Hundreds	115+ million

Exhibit 74: Africa

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-05/31	Drought	South Africa	N/A	N/A	1.2+ billion
01/03-01/04	Flooding	Democratic Republic of Congo	44	465+	Millions
01/12-01/13	Cyclone Ava	Madagascar	73	4,800+	10s of Millions
01/14-01/21	Flooding	Burundi	0	2,000+	Millions
01/15-01/18	Cyclone Berguitta	Mauritius, La Reunion	0	Thousands	10s of Millions
01/16-01/22	Flooding	Mozambique	11	15,000+	Millions
02/07-02/09	Flooding	Malawi	16	2,000+	Unknown
02/22-03/07	Flooding	Angola, Malawi, Rwanda	8	6,500+	Millions
03/01-03/04	Flooding	Kenya	7	Thousands	Millions
03/01-03/11	Flooding	Rwanda	24	1,000+	22+ million
03/17-03/18	Cyclone Eliakim	Madagascar	21	17,228+	Millions
03/22-03/23	Flooding	South Africa, Lesotho	19	Thousands	Millions
03/14-05/31	Flooding	Kenya	226	Thousands	350+ million
03/14-05/31	Flooding	Uganda	N/A	Thousands	150+ million
04/01-04/16	Flooding	Rwanda	10	300+	11+ million
04/01-05/31	Flooding	Somalia	5	Thousands	80+ million
04/14-04/16	Flooding	Tanzania	15	Hundreds	Unknown
04/14-04/17	Flooding	Ethiopia	2	Thousands	Millions
04/24	Tropical Storm Fakir	Réunion	2	Hundreds	19+ million
04/25-04/27	Flooding	Rwanda	41	Hundreds	11+ million
05/19-05/21	Tropical Storm Sagar	Somalia, Djibouti, Yemen	79	Thousands	10s of Millions
05/26	Flooding	Ethiopia	23	5,000+	Millions
06/02-06/03	Flooding	Rwanda	18	Hundreds	Millions
06/18-06/29	Flooding	Ivory Coast, Ghana, Nigeria	33	Thousands	Millions
07/13-07/16	Flooding	Nigeria	12	2,000+	Millions
07/15-08/23	Flooding	Sudan	23	8,900+	Millions
07/25-08/10	Flooding	Niger	22	18,140+	Millions
09/01-09/30	Flooding	Ghana	34	20,000+	Millions
09/01-09/30	Flooding	Nigeria	199	17,816+	275+ million
09/04	Landslide	Ethiopia	12	Unknown	Negligible
09/22	Flooding	Tunisia	5	2,500+	36+ million
10/11	Flooding	Uganda	51	Hundreds	Unknown

Exhibit 75: Middle East

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/19-01/20	Winter Weather	Lebanon	15	N/A	Negligible
02/16-02/18	Flooding	Turkey, Iran, Iraq, Lebanon	3	Hundreds	Millions
03/07	Earthquake	Iran	0	5,500+	Millions
03/24	Severe Weather	Turkey	0	Thousands	Millions
04/25-04/26	Flooding	Israel	11	Hundreds	Millions
05/23-05/27	Cyclone Mekunu	Yemen, Oman, Saudi Arabia	31	5,000+	1.5+ billion
07/08	Landslide	Turkey	24	N/A	Unknown
07/22	Earthquake	Iran	0	1,000+	10s of Millions
08/26	Earthquake	Iran	2	2,600+	Millions
10/05-10/06	Flooding	Iran	9	2,650+	166+ million
10/14	Cyclone Luban	Yemen, Oman	24	Hundreds	1.0 billion
10/20	Flooding	Qatar	0	Hundreds	10s of Millions
10/26	Flooding	Jordan	21	Hundreds	Millions
11/09-11/10	Flooding	Jordan, Kuwait, Saudi Arabia, Iraq	44	Thousands	400+ million
11/22-11/23	Flooding	Iraq	21	300+	Unknown
11/25	Earthquake	Iran	0	15,000+	10s of Millions

Exhibit 76: Asia

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-01/02	Tropical Storm Bolaven	Philippines	3	2,000+	12 million
01/01-01/07	Winter Weather	India, Nepal	94	N/A	Negligible
01/02-01/05	Winter Weather	China	21	3,500+	854+ million
01/13-01/17	Flooding	Philippines	11	1,900+	Millions
01/21-01/25	Winter Weather	Japan	5	2,000+	100+ million
01/23	Earthquake	Indonesia	1	12,000+	80+ million
01/24-01/29	Winter Weather	China	2	3,000+	1.45+ billion
02/05-02/06	Flooding	Indonesia	4	7,228+	200+ million
02/06	Earthquake	Taiwan	17	10,000+	100+ million
02/12-02/14	Tropical Storm Sanba	Philippines	0	2,000+	<10 million
02/16-02/28	Severe Weather	India	0	5,000+	47+ million
02/21-02/23	Flooding	Indonesia	20	20,000+	250+ millions
03/03	Severe Weather	China	14	59,000+	147+ million
03/15-03/18	Severe Weather	China	5	2,000+	50+ million
03/20-03/27	Flooding	Russia	2	2,000+	Millions+
03/29	Severe Weather	China	0	2000+	30+ million
04/02-04/18	Winter Weather	China	0	5,000+	3.4+ billion
04/11	Severe Weather	India	42	15,000+	100+ million

Exhibit 76: Asia (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
04/17	Severe Weather	India	18	10,000+	100+ million
04/19-04/25	Severe Weather	China	1	2,200+	91+ million
04/29-04/30	Severe Weather	Bangladesh	33	Unknown	Unknown
05/02-05/03	Severe Weather	India	143	Thousands	24+ million
05/06-05/09	Severe Weather	India	32	4,200+	50+ million
05/07-05/15	Flooding	Afghanistan, Pakistan	78	Thousands	Millions
05/07-05/14	Flooding	China	2	2,000+	31+ million
05/12-05/17	Severe Weather	China	2	2,000+	67+ Million
05/13-05/16	Severe Weather	India	95	Hundreds	Millions+
05/17-05/20	Flooding	India	6	2,422+	10+ Million
05/17-05/21	Flooding	Tajikistan	6	1,145+	Millions
05/20-06/20	Heatwave	Pakistan	180	N/A	N/A
05/28-05/29	Severe Weather	India	54	5,000+	25+ million
05/28	Earthquake	China	0	15,900+	29 million
05/05-07/31	Flooding	China	112	150,000+	1.75+ billion
06/01-08/20	Flooding	India	1,100	20,000+	700+ million
06/01-08/28	Flooding	India (Kerala)	324	40,000+	4.4+ billion
06/01-06/06	Severe Weather	India	42	Hundreds	Millions
06/06-06/07	Severe Weather	China	2	800+	31+ Million
06/02-06/07	Tropical Storm Ewiniar	Vietnam, China	15	5,500+	810+ Million
06/09-06/12	Severe Weather	China	0	Thousands	91+ Million
06/08-06/12	Severe Weather	India	61	10,000+	50+ million
06/05-06/14	Flooding	Bangladesh, Myanmar	26	5,000+	Unknown
06/12-06/21	Severe Weather	China	2	12,000+	317+ million
06/18	Earthquake	Japan	5	166,000+	3.25+ billion
06/23-06/27	Flooding	Vietnam	33	3,776 +	23+ million
06/28-07/05	Severe Weather	China	11	12,000+	278+ million
06/29-07/03	Severe Weather	China	5	8,000+	157+ million
07/02-07/03	Tropical Storm Prapiroon	Japan, South Korea	4	7,500+	125+ million
07/05-07/08	Flooding	Japan	246	65,000+	10+ billion
07/01-07/25	Heatwave	Japan, Korea, China	180+	N/A	Unknown
07/01-07/03	Flooding	Pakistan, India, Nepal	21	2,000+	Millions
07/01-09/30	Flooding	China (Pearl River Delta), Vietnam	38(15)	50,000+	2.0+ (1.8+) billion
07/01-09/30	Flooding	China (north)	89	175,000+	5.75+ billion
07/07-07/11	Severe Weather	China	1	2,000+	33+ million
07/08-07/25	Flooding	Russia	0	6,000+	16+ million
07/10-07/11	Flooding	China	19	18,300+	580+ million
07/10-07/12	Typhoon Maria	China, Taiwan	2	15,000+	623+ million

Exhibit 76: Asia (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
07/13-07/20	Flooding	China	0	500+	53+ million
07/17-07/24	Tropical Storm Sonh-Tinh	Vietnam, Laos, China, Philippines	170	20,000+	255+ million
07/17-07/31	Flooding	Philippines	16	5,050+	88+ million
07/17-07/26	Flooding	Laos, Cambodia	150	5,000+	Millions
07/22-07/25	Tropical Storm Ampil	China	1	10,000+	240+ million
07/22-07/25	Severe Weather	China	6	15,000+	295+ million
07/27-08/03	Tropical Storm Jongdari	Japan, China	0	5,000+	715+ Million
07/28	Earthquake	Indonesia	20	17,000+	29+ million
07/28-07/30	Flooding	Myanmar, Thailand	19	Thousands	Unknown
08/05, 08/09	Earthquake	Indonesia	560	105,000+	790+ million
08/03-08/08	Severe Weather	China	6	2,000+	40+ million
08/13	Earthquake	China	0	6,000+	50+ million
08/09-08/15	Tropical Storm Yagi	Philippines, China	7	7,500+	365+ million
08/13-08/19	Tropical Storm Bebinca	China, Vietnam	16	12,000+	236+ million
08/16-08/18	TY Rumbia	China	53	40,000+	5.4+ billion
08/19	Earthquake	Indonesia	14	1,705+	5+ million
08/19-08/23	Flooding	China	5	3,100+	33+ million
08/23-08/25	Typhoon Soulik	Japan, Korea Peninsula, China, Russia	86	2,000+	81+ million
08/23-08/26	Typhoon Cimaron	Japan	0	2,000+	100 million
08/23-08/26	Flooding	Taiwan	7	5,000+	34+ million
08/24	Flooding	Afghanistan	11	Hundreds	Millions
08/28-08/29	Flooding	South Korea	1	2,000+	25+ million
08/29-09/07	Flooding	North Korea	150	12,000+	25+ million
09/03	Earthquake	China	0	2,630+	5.2+ million
09/04-09/05	Typhoon Jebi	Japan	17	826,000+	13+ billion
09/06	Earthquake	Japan	44	36,000+	1.25+ billion
09/15-09/18	Typhoon Mangkhut	N. Mariana Islands, Philippines, China, HK	161	300,000+	6+ billion
09/13-09/14	Tropical Storm Barijat	China	0	3,500+	7.5+ million
09/28	Earthquake	Indonesia	2,256	100,000+	1.45+ billion
09/28-10/02	Typhoon Trami	Japan	4	355,000+	4.5+ billion
10/06-10/12	Flooding	Sri Lanka	12	5,000+	25 million
10/06-10/07	Typhoon Kong-Rey	South Korea, Japan	4	7,500+	200+ million
10/11-10/13	Cyclone Titli	India	85	75,000+	920+ million
10/12	Flooding	Indonesia	27	500+	Unknown
10/30	Typhoon Yutu	Philippines	18	10,000+	305+ million
11/02-11/11	Winter Weather	China	0	2,750+	2+ million

Exhibit 76: Asia (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
11/16-18	Cyclone Gaja	India	63	150,000+	775+ million
11/17-11/18	Tropical Depression Toraji	Vietnam	19	5,000+	17+ million
11/25	TS Usagi	Vietnam, Philippines	2	10,000+	50+ million
12/08-12/10	Flooding	Vietnam	14	35,000+	25+ million
12/17-12/19	Cyclone Phethai	India	8	10,000+	100+ million
12/22	Earthquake/ Tsunami	Indonesia	431	3,500+	250+ million
12/28-12/31	Tropical Depression 35W	Philippines	150	3,000+	10+ million
12/30-12/31	Winter Weather	China	0	5,000+	175+ million
01/01-10/31	Drought	China	0	N/A	3.55+ billion
01/01-12/31	Drought	India	0	N/A	3.65+ billion

Exhibit 77: Oceania (Australia, New Zealand, and the South Pacific Islands)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-08/01	Drought	Australia	N/A	Thousands	1.0+ billion
01/04-01/07	Severe Weather	New Zealand	0	4,200+	50+ million
01/31-02/02	Flooding (Fehi)	New Zealand	0	10,000+	67+ million
02/09-02/20	Cyclone Gita	Tonga, Fiji, Samoa, New Zealand	1	10,000+	250+ million
02/18-02/20	Tropical Storm Kelvin	Australia	0	4,000+	25+ million
02/26	Earthquake	Papua New Guinea	160	50,000+	190+ million
03/05-03/08	Earthquake	Papua New Guinea	36	Unknown	Millions
03/09-03/11	Flooding	Australia	0	2,000+	40+ million
03/17-03/19	Wildfire	Australia	0	1,050+	90+ million
03/17	Cyclone Marcus	Australia	0	6,377+	75+ million
03/24-03/27	Cyclone Nora	Australia	0	2,000+	25+ million
03/31	Cyclone Josie	Fiji	6	Unknown	10+ million
04/10	Cyclone Keni	Fiji	0	2,000+	50+ million
04/10-04/11	Severe Weather	New Zealand	0	13,000+	87+ million
04/27-04/29	Flooding	New Zealand	0	2,000+	25+ million
05/10-05/14	Flooding	Australia	0	8,800+	130+ million
06/11	Flooding	New Zealand	0	5,000+	25+ million
10/11	Severe Weather	Australia	0	7,500+	50+ million
11/28-11/29	Severe Weather	Australia	3	3,000+	25+ million
12/10-12/16	Cyclone Owen	Australia	1	2,500+	25+ million
12/13-12/16	Severe Weather	Australia	0	15,000+	70+ million
12/19-12/20	Severe Weather	Australia	0	50,000+	875+ million

Appendix B: Historical Natural Disaster Events

The following tables provide a look at specific global natural disaster events since 1900. (Please note that the adjusted for inflation (2018 USD) totals were converted using the U.S. Consumer Price Index (CPI). Insured losses include those sustained by private industry and government entities such as the U.S. National Flood Insurance Program (NFIP). Please note that some of these values have been rounded to the nearest whole number.

For additional top 10 lists, please visit **http://catastropheinsight.aon.com.**

Exhibit 78: Top 10 Costliest Global Economic Loss Events (1900-2018)

Date(s)	Event	Location	Economic Loss[1] Actual (USD)	Economic Loss[1,2] (2018 USD)
March 11, 2011	Tohoku Earthquake/Tsunami	Japan	220 billion	247 billion
January 16, 1995	Great Hanshin Earthquake	Japan	103 billion	171 billion
August 2005	Hurricane Katrina	United States	125 billion	160 billion
August 2017	Hurricane Harvey	United States	125 billion	128 billion
May 12, 2008	Sichuan Earthquake	China	86 billion	100 billion
September 2017	Hurricane Maria	Puerto Rico, Caribbean	90 billion	92 billion
October 2012	Hurricane Sandy	U.S., Caribbean, Canada	77 billion	84 billion
January 17, 1994	Northridge Earthquake	United States	44 billion	76 billion
September 2017	Hurricane Irma	U.S., Caribbean	71 billion	72 billion
November 23, 1980	Irpinia Earthquake	Italy	20 billion	59 billion

Exhibit 79: Top 10 Costliest Global Insured Loss Events (1900-2018)

Date(s)	Event	Location	Insured Loss[3] Actual (USD)	Insured Loss[2,3] (2018 USD)
August 2005	Hurricane Katrina	United States	65 billion	83 billion
March 11, 2011	Tohoku Earthquake/ Tsunami	Japan	35 billion	39 billion
October 2012	Hurricane Sandy	United States	30 billion	33 billion
August 2017	Hurricane Harvey	United States	30 billion	31 billion
September 2017	Hurricane Maria	Puerto Rico, Caribbean	30 billion	30 billion
September 2017	Hurricane Irma	U.S, Caribbean	28 billion	29 billion
August 1992	Hurricane Andrew	U.S., Bahamas	16 billion	28 billion
January 17, 1994	Northridge Earthquake	United States	15 billion	26 billion
September 2008	Hurricane Ike	U.S., Caribbean	18 billion	21 billion
June-December 2011	Thailand Floods	Thailand	16 billion	17 billion

[1] Economic loss include those sustained from direct damages, plus additional directly attributable event costs
[2] Adjusted using US Consumer Price Index (CPI)
[3] Losses sustained by private insurers and government-sponsored programs

Exhibit 80: Top 10 Costliest Tropical Cyclones: Economic Loss (1900-2018)

Date(s)	Event	Location	Economic Loss[4] Actual (USD)	Economic Loss[4,5] (2018 USD)
August 2005	Hurricane Katrina	United States	125 billion	160 billion
August 2017	Hurricane Harvey	United States	125 billion	128 billion
September 2017	Hurricane Maria	U.S., Caribbean	90 billion	92 billion
October 2012	Hurricane Sandy	U.S., Caribbean, Canada	77 billion	84 billion
September 2017	Hurricane Irma	U.S., Caribbean	71 billion	72 billion
August 1992	Hurricane Andrew	U.S., Bahamas	27 billion	49 billion
September 2008	Hurricane Ike	U.S., Caribbean	38 billion	44 billion
September 2004	Hurricane Ivan	U.S., Caribbean	27 billion	36 billion
October 2005	Hurricane Wilma	U.S., Caribbean	28 billion	35 billion
September 1989	Hurricane Hugo	U.S., Caribbean	13 billion	26 billion

Exhibit 81: Top 10 Costliest Tropical Cyclones: Insured Loss (1900-2018)

Date(s)	Event	Location	Insured Loss[6] Actual (USD)	Insured Loss[5,6] (2018 USD)
August 2005	Hurricane Katrina	United States	65 billion	83 billion
October 2012	Hurricane Sandy	U.S., Caribbean, Canada	30 billion	33 billion
August 2017	Hurricane Harvey	United States	30 billion	31 billion
September 2017	Hurricane Maria	U.S., Caribbean	30 billion	30 billion
September 2017	Hurricane Irma	U.S., Caribbean	28 billion	29 billion
August 1992	Hurricane Andrew	U.S., Caribbean	16 billion	28 billion
September 2008	Hurricane Ike	U.S., Caribbean	18 billion	21 billion
October 2005	Hurricane Wilma	U.S., Caribbean	13 billion	16 billion
September 2004	Hurricane Ivan	U.S., Caribbean	11 billion	14 billion
September 2005	Hurricane Rita	U.S., Caribbean	9 billion	12 billion

[4] *Economic loss include those sustained from direct damages, plus additional directly attributable event costs*
[5] *Adjusted using US Consumer Price Index (CPI)*
[6] *Losses sustained by private insurers and government-sponsored programs*

Exhibit 82: Top 10 Costliest Individual Wildfires: Insured Loss (1900-2018)

Date(s)	Event	Location	Insured Loss[7] Actual (USD)	Insured Loss[7,8] (2018 USD)
November 2018	Camp Fire	United States	12 billion	12 billion
October 2017	Tubbs Fire	United States	8.7 billion	8.9 billion
November 2018	Woolsey Fire	United States	4.5 billion	4.5 billion
October 1991	Oakland (Tunnel) Fire	United States	1.7 billion	3.1 billion
October 2017	Atlas Fire	United States	3.0 billion	3.1 billion
May 2016	Horse Creek Fire	Canada	2.8 billion	3.0 billion
December 2017	Thomas Fire	United States	2.2 billion	2.3 billion
October 2007	Witch Fire	United States	1.6 billion	1.9 billion
October 2003	Cedar Fire	United States	1.1 billion	1.4 billion
October 2003	Old Fire	United States	975 million	1.3 billion

Exhibit 83: Top 10 Global Human Fatality Events in the Modern Era (1950-2018)

Date(s)	Event	Location	Economic Loss[9] Actual (USD)	Insured Loss[7] Actual (USD)	Fatalities
November 12, 1970	Cyclone Bhola	Bangladesh	90 million	N/A	300,000
July 27, 1976	Tangshan Earthquake	China	5.6 billion	N/A	242,769
December 26, 2004	Indian Ocean Earthquake/Tsunami	Indian Ocean Basin	14 billion	3 billion	227,899
January 12, 2010	Port-au-Prince Earthquake	Haiti	8 billion	200 million	222,570
April 1991	Cyclone Gorky	Bangladesh	1.8 billion	100 million	139,000
May 2008	Cyclone Nargis	Myanmar	10 billion	N/A	138,366
August 1971	Vietnam Floods	Vietnam	N/A	N/A	100,000
October 8, 2005	Kashmir Earthquake	Pakistan	6.7 billion	50 million	88,000
May 12, 2008	Sichuan Earthquake	China	86 billion	366 million	87,652
May 31, 1970	Ancash Earthquake	Peru	530 million	N/A	66,794

[7] *Losses sustained by private insurers and government-sponsored programs*
[8] *Adjusted using US Consumer Price Index (CPI)*
[9] *Economic loss include those sustained from direct damages, plus additional directly attributable event costs*

Appendix C: Tropical Cyclone Activity & Landfalls

The following shows tropical cyclone activity and landfalls by basin. Note that data for the Atlantic and Western Pacific Basins in this section extend to 1950 given the level of quality data as provided by NOAA's IBTrACS historical tropical cyclone database. All other basins include data to 1980.

Atlantic Ocean Basin

Exhibit 84: Atlantic Basin Tropical Cyclone Activity

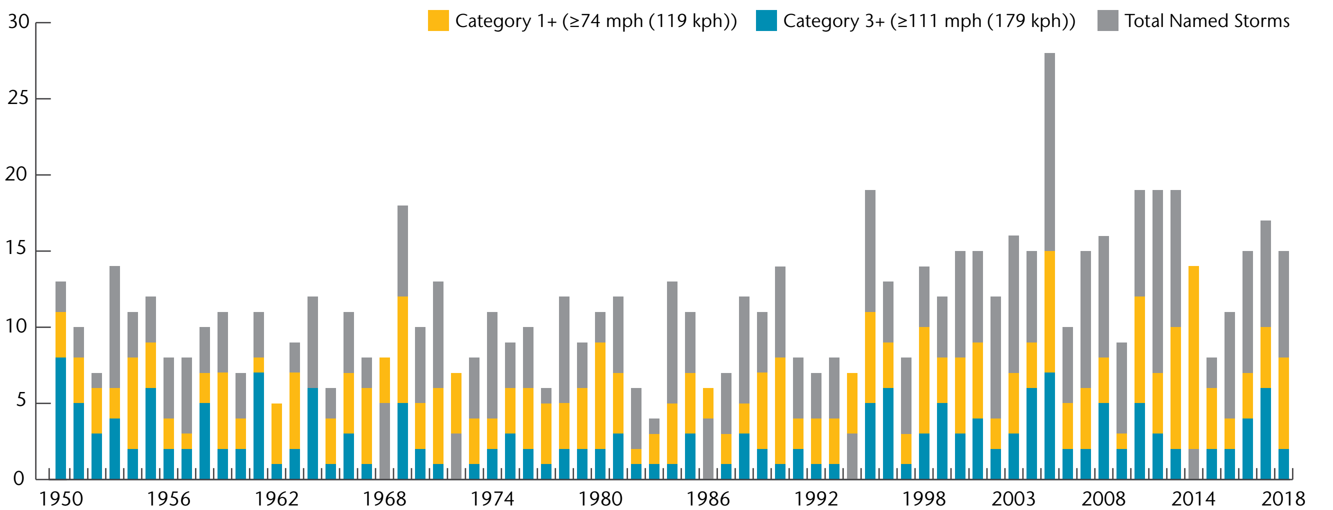


Exhibit 85: Atlantic Basin Hurricane & Major Hurricane Landfalls

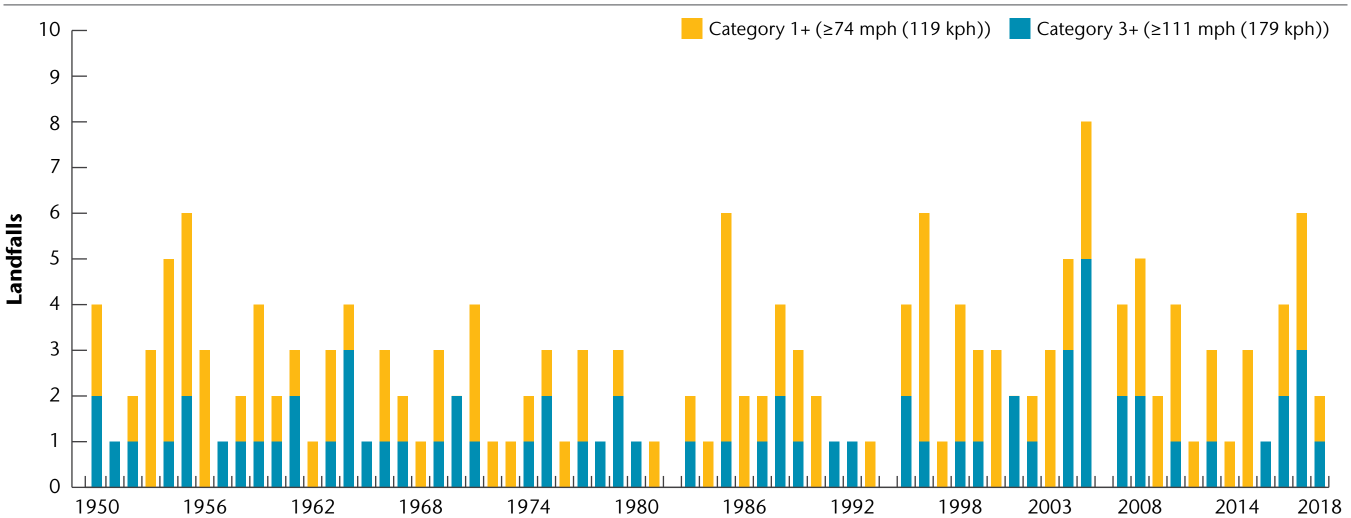


Exhibit 86: United States Hurricane & Major Hurricane Landfalls

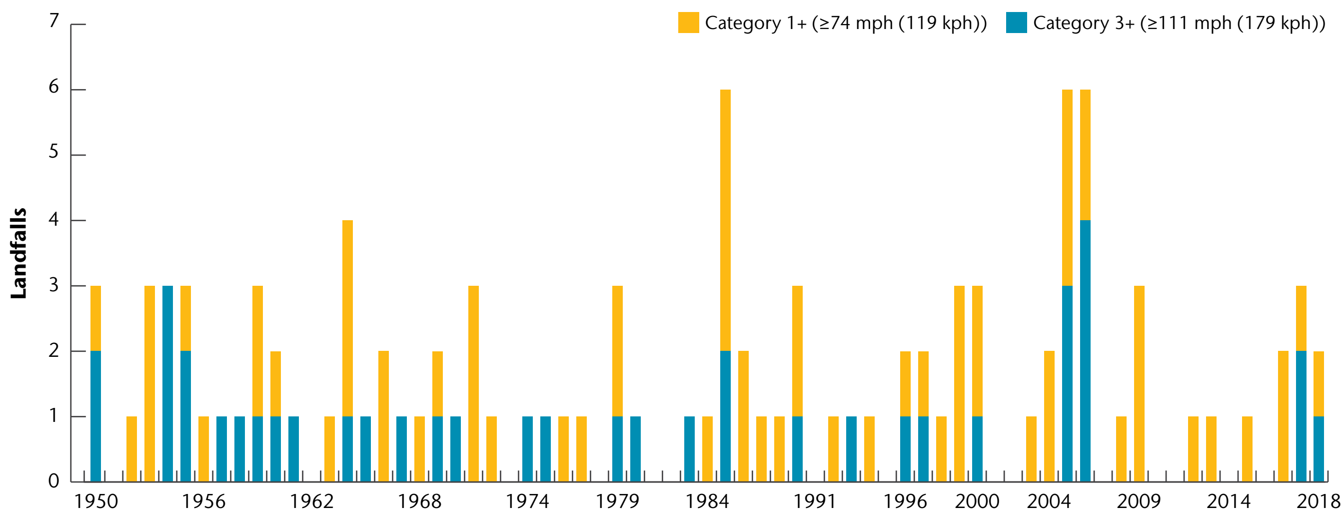
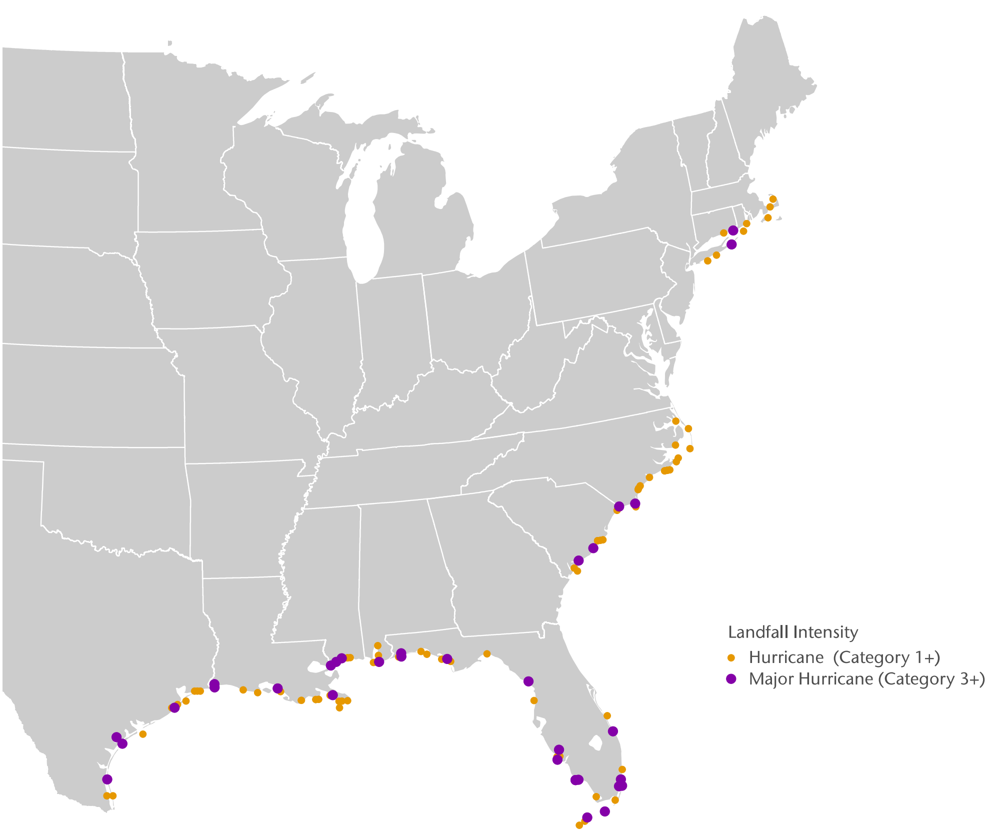


Exhibit 87: United States Hurricane & Major Hurricane Landfall Map



Eastern Pacific Ocean Basin

Exhibit 88: Eastern & Central Pacific Basin Tropical Cyclone Activity

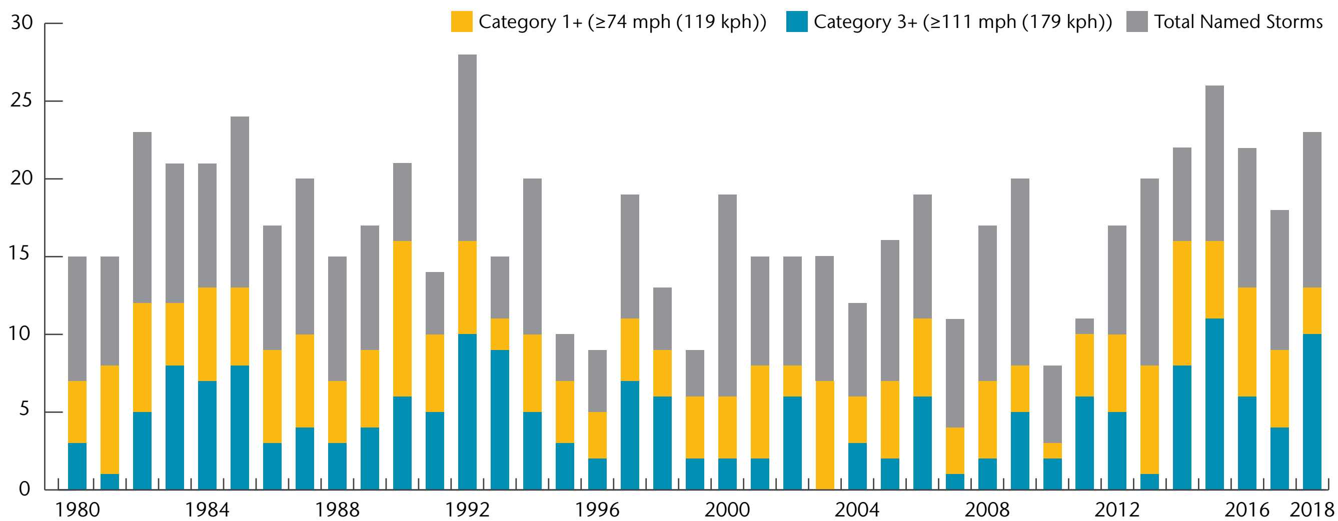
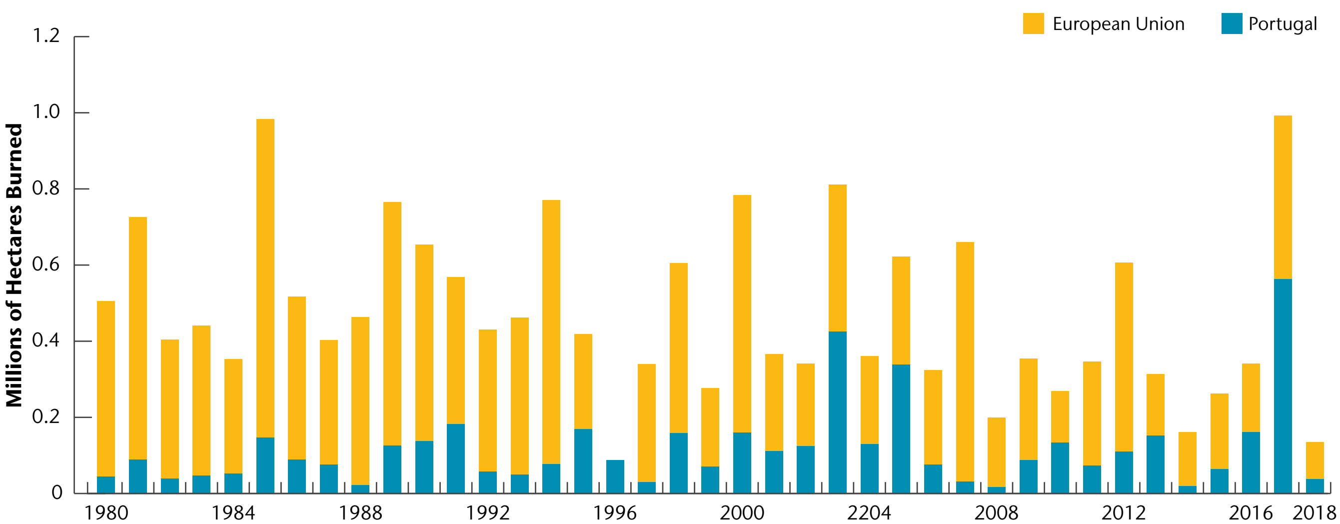


Exhibit 89: Eastern & Central Pacific Basin Hurricane & Major Hurricane Landfalls



Western Pacific Ocean Basin

Exhibit 90: Western Pacific Basin Tropical Cyclone Activity

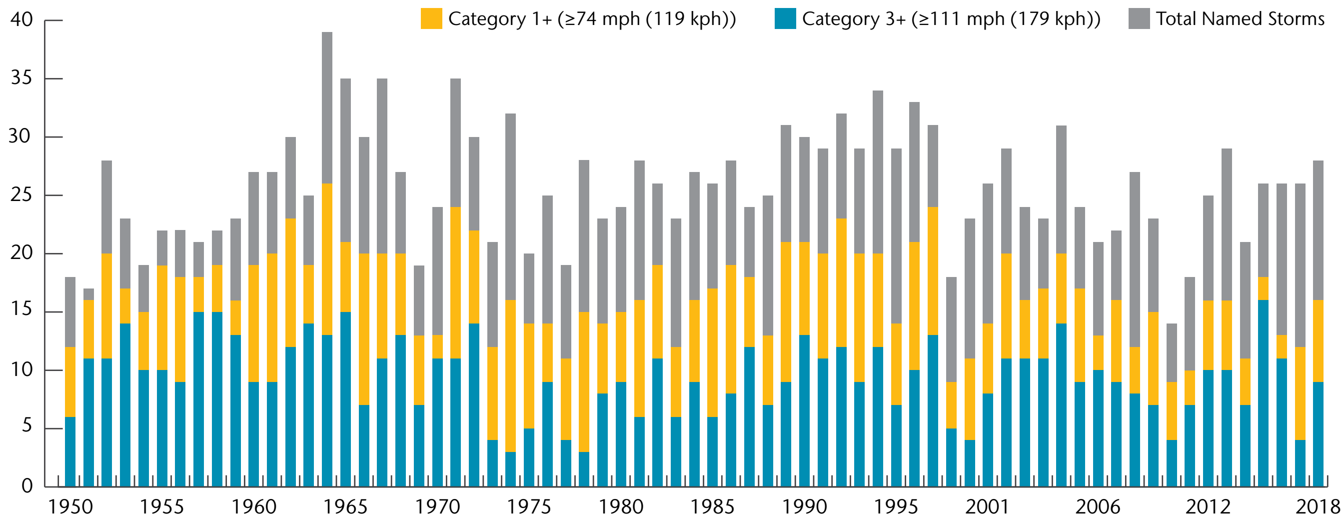
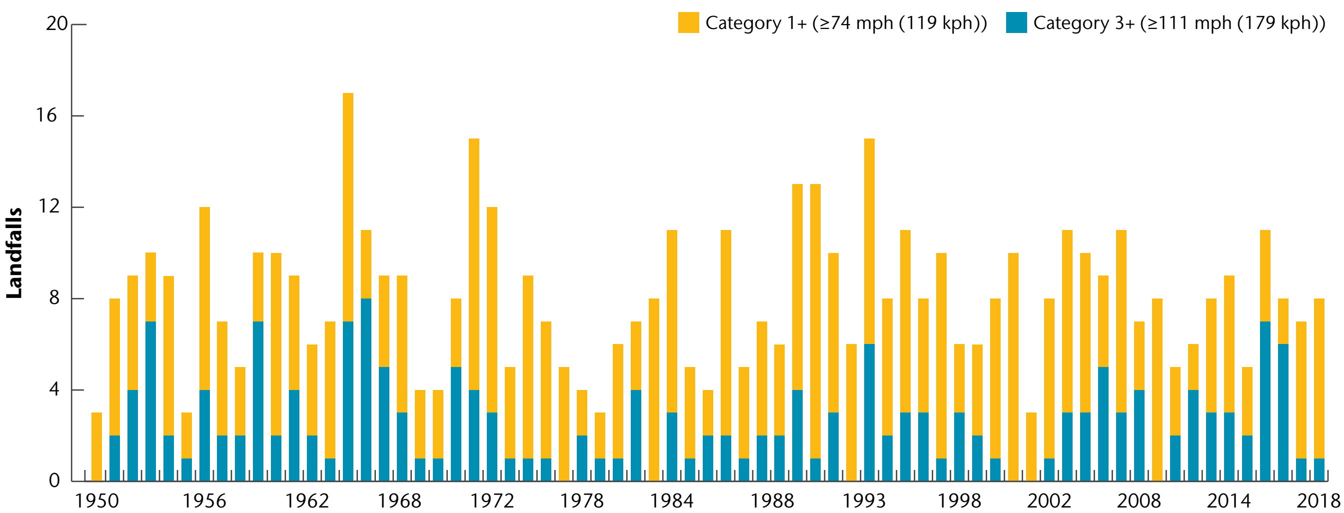


Exhibit 91: Western Pacific Basin Typhoon Landfalls



North Indian Ocean Basin

Exhibit 92: North Indian Basin Tropical Cyclone Activity

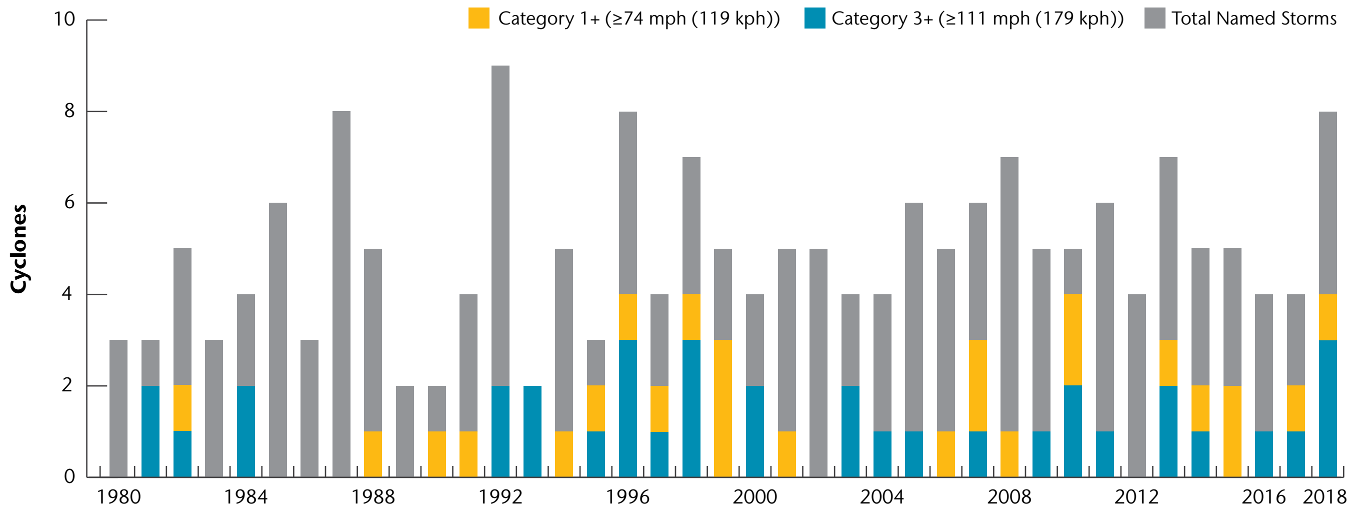
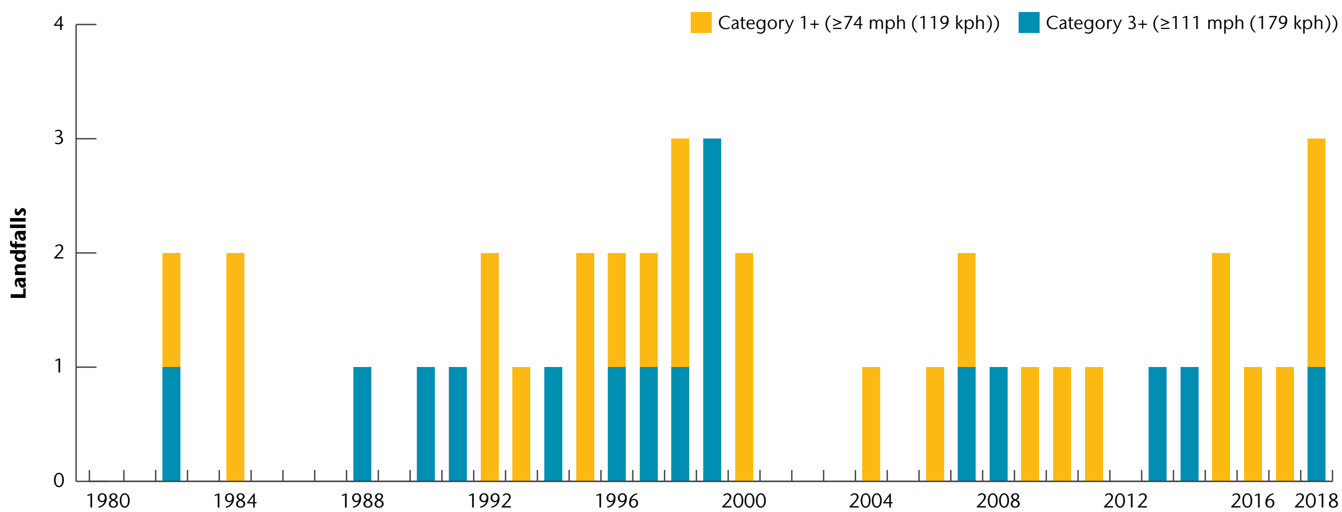


Exhibit 93: North Indian Basin Tropical Cyclone Landfalls



Southern Hemisphere

Exhibit 94: Southern Hemisphere Tropical Cyclone Activity

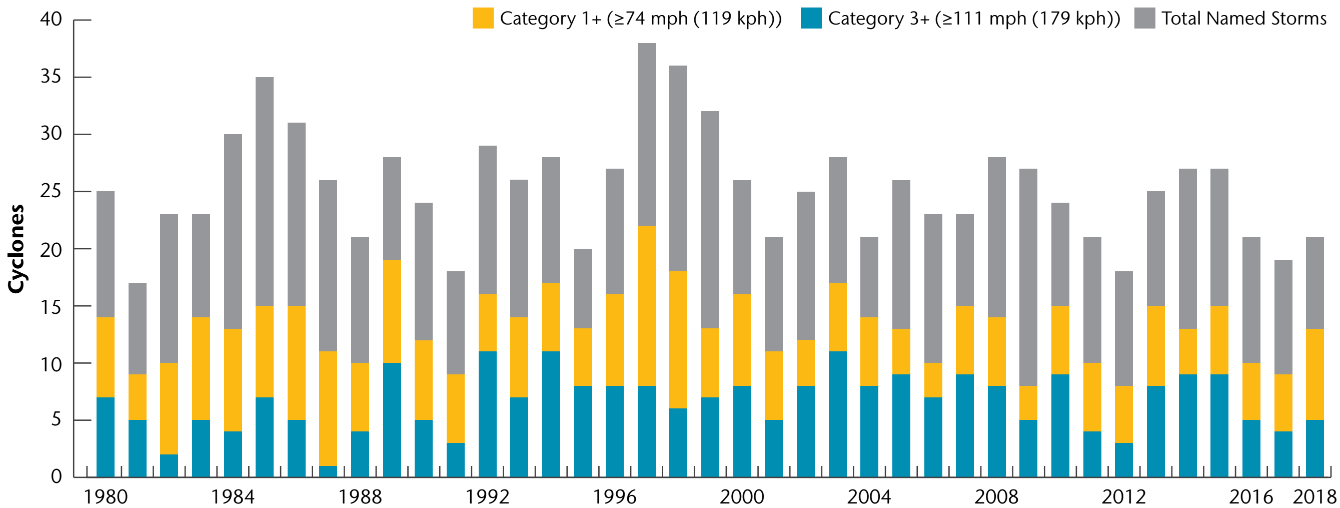
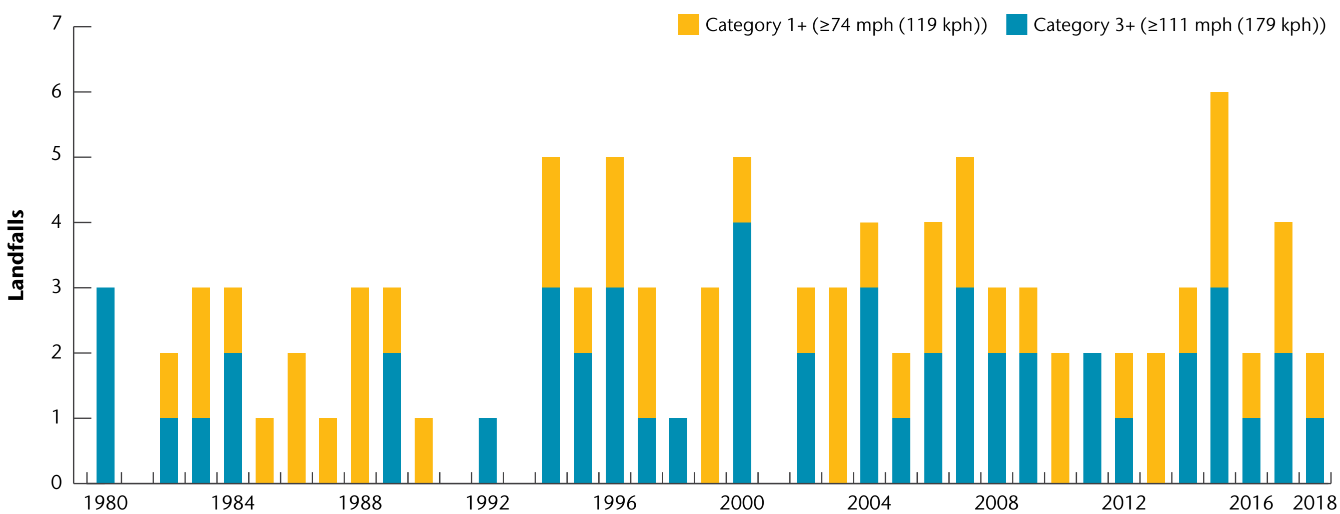


Exhibit 95: Southern Hemisphere Tropical Cyclone Landfalls



Appendix D: United States Severe Weather Data

Given the increased cost of severe weather-related damage in the United States during the past decade for insurers, the following is a breakout of tornadoes, tornado fatalities, large hail (2.0" or larger), and damaging straight-line winds (75 mph or greater). The data comes via NOAA's Storm Prediction Center. Please note that data prior to 1990 are often considered incomplete given a lack of reporting. **The implementation of Doppler radar, greater social awareness and increased reporting has led to more accurate datasets in the last 30 years.** Data from 2018 is to be considered preliminary.

Exhibit 96: U.S. Tornadoes

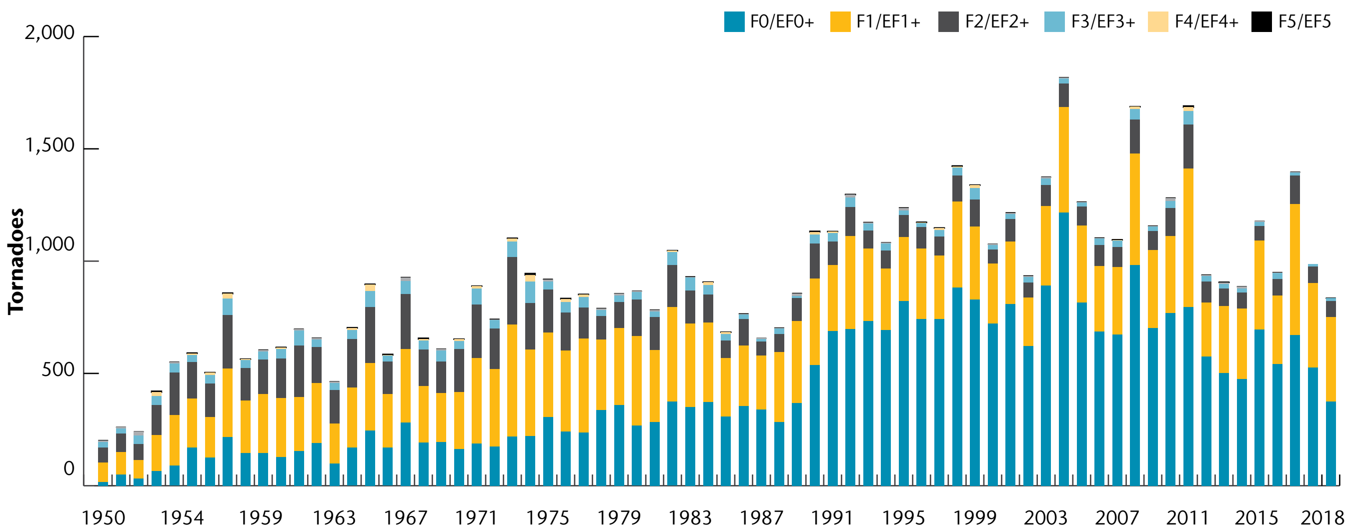


Exhibit 97: U.S. Tornadoes (F3/EF3+)

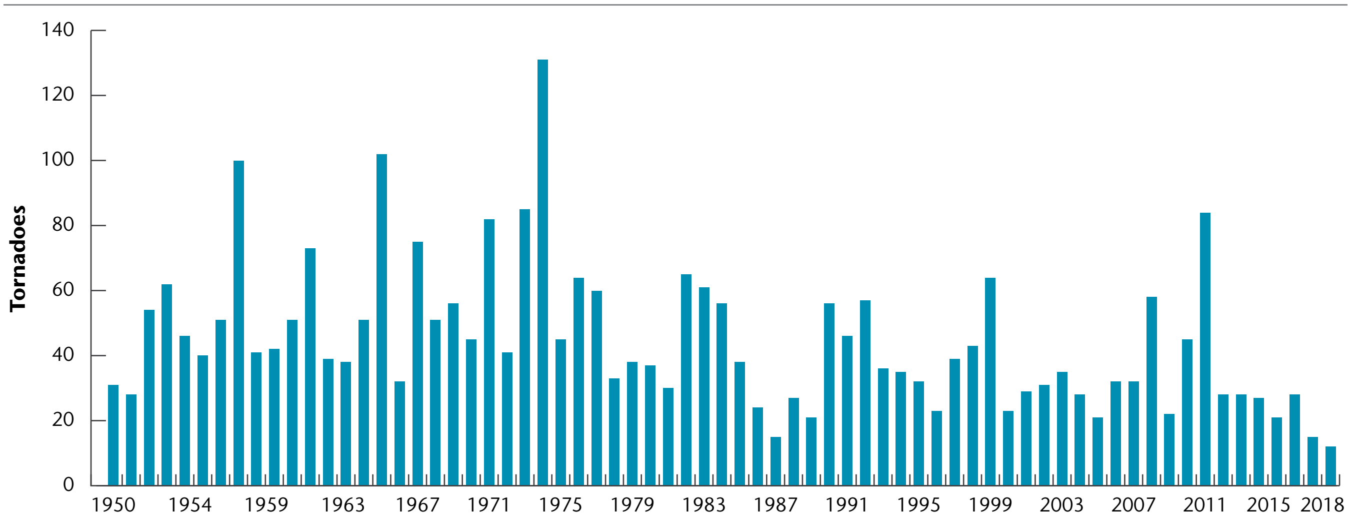


Exhibit 98: U.S. Large Hail Reports (2.0" or Larger)

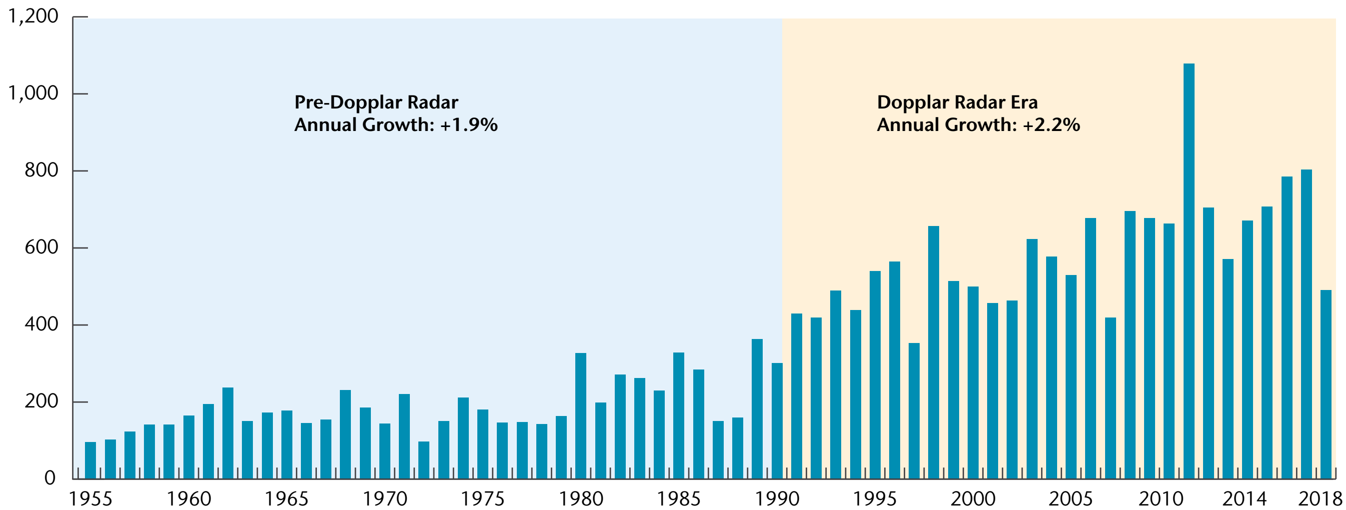
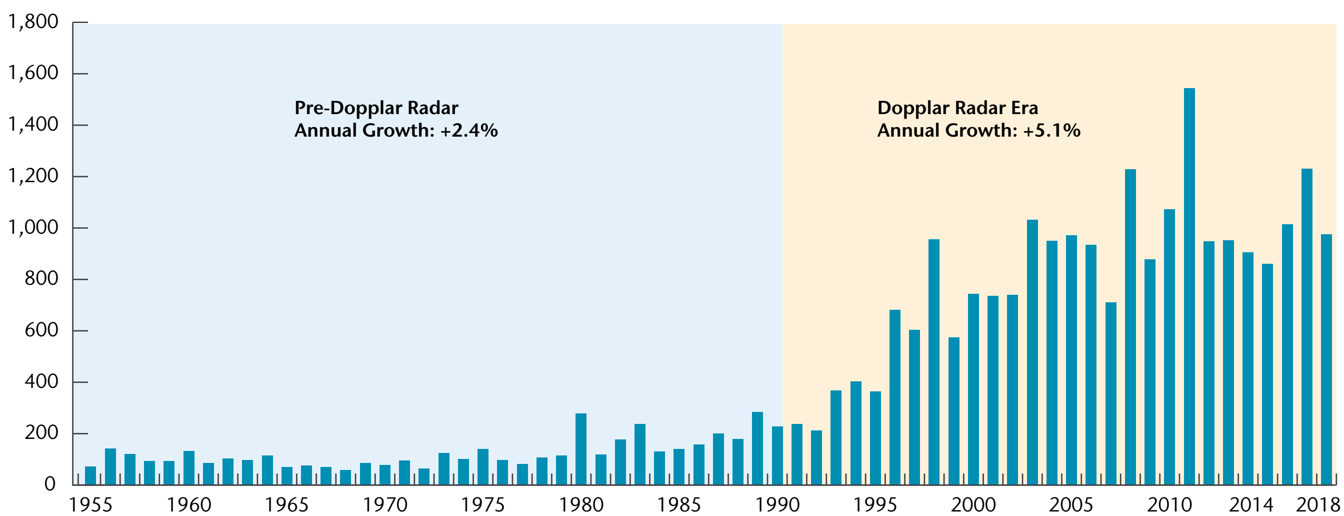


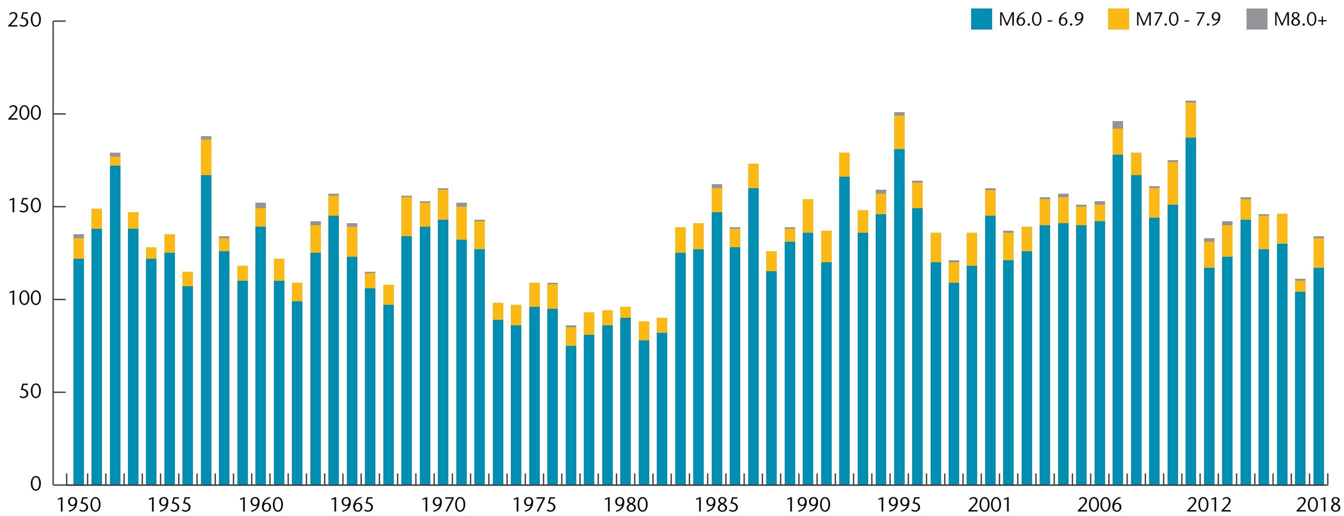
Exhibit 99: U.S. Damaging Wind Reports (75 mph or Greater)



Appendix E: Global Earthquakes

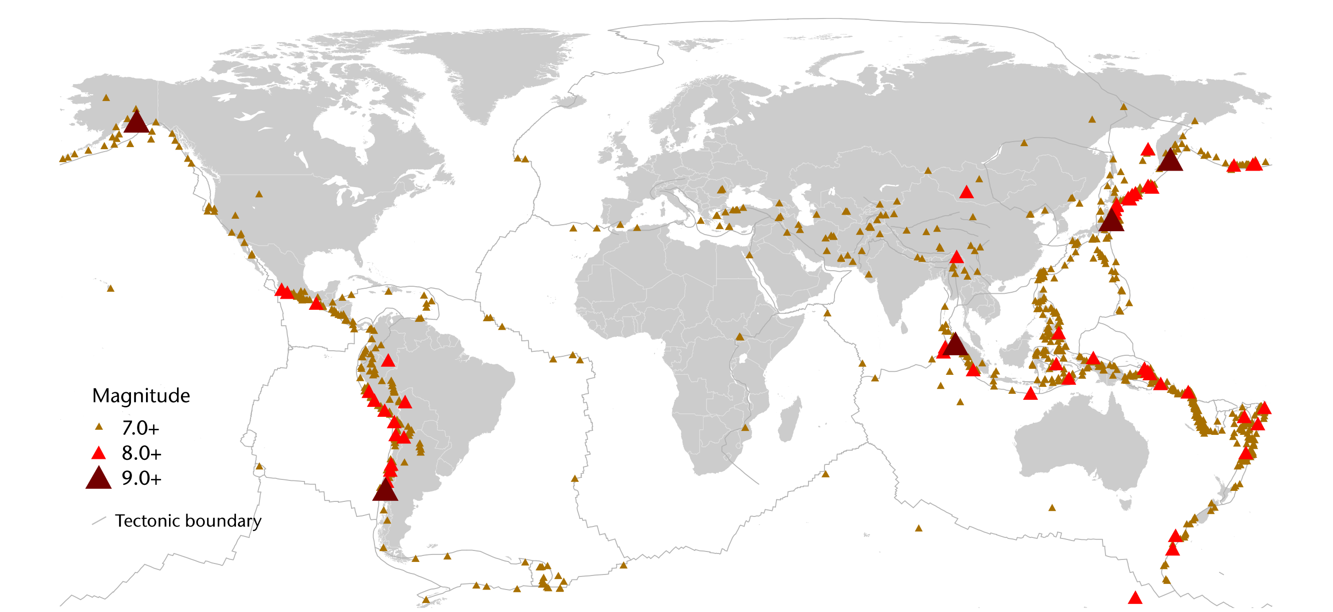
Based on historical data from the United States Geological Survey, there were at least 134 earthquakes in 2018 with magnitudes of 6.0 or greater. It was also the first year since 1989 to have fewer than 10 tremors of at least magnitude-7.0 intensity. Despite the reduction in 2018, overall earthquake activity does not often show large fluctuations on an annual basis. This is especially true given the extensive network of global seismograph stations that has led to a robust and thorough dataset over the past several decades.

Exhibit 100: Global Earthquakes (M6.0+)



Source: USGS

Exhibit 101: Global Earthquake Map; M6.0+ (1950-2018)

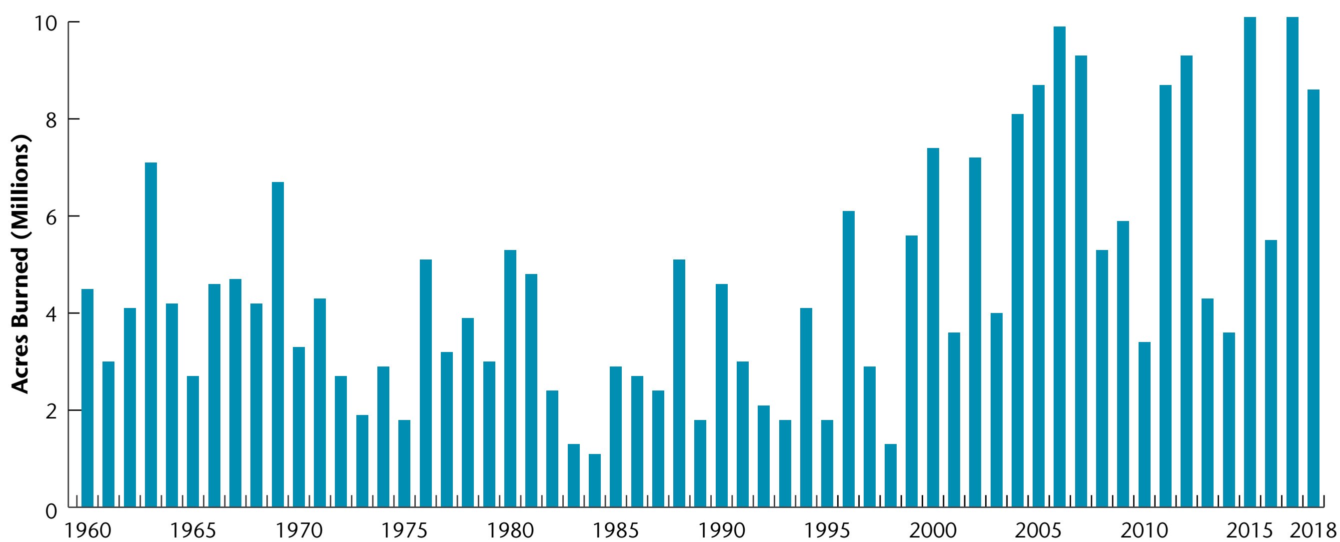


Source: USGS

Appendix F: United States & Europe Wildfire Data

The following wildfire data in the United States is provided from the National Interagency Fire Center (NIFC), which began compiling statistics under their current methodology in 1983. Previous data was collected by the National Interagency Coordination Center (NICC) from 1960 to 1982 but used a different methodology. **It is not advised to compare pre-1983 data to post-1983 data given these different data collection methods**. The European data comes via the European Forest Fire Information System (EFFIS), which is maintained by the European Union's Copernicus group.

Exhibit 102: United States Wildfire Acres Burned

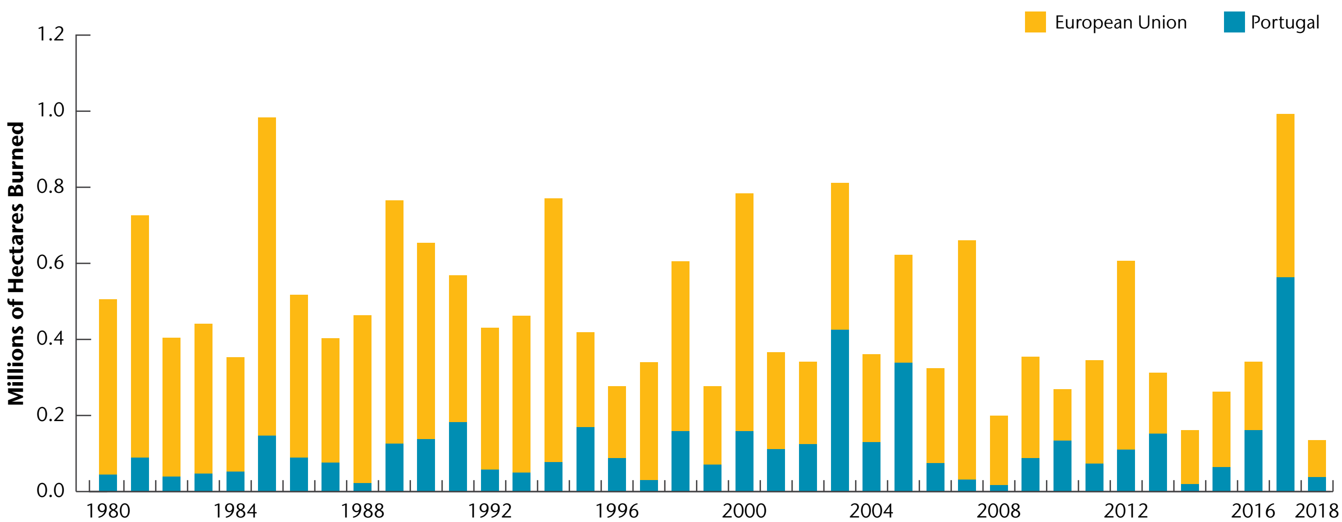


Source: NIFC

Exhibit 103: Top 10 Acres Burned by State in 2018

Source: NIFC

Exhibit 104: Forest Fires in the European Union



Additional Report Details

TD = Tropical Depression, TS = Tropical Storm, HU = Hurricane, TY = Typhoon, STY = Super Typhoon, CY = Cyclone

Fatality estimates as reported by public news media sources and official government agencies.

Structures defined as any building — including barns, outbuildings, mobile homes, single or multiple family dwellings, and commercial facilities — that is damaged or destroyed by winds, earthquakes, hail, flood, tornadoes, hurricanes or any other natural-occurring phenomenon. Claims defined as the number of claims (which could be a combination of homeowners, commercial, auto and others) reported by various insurance companies through press releases or various public media outlets.

Damage estimates are obtained from various public media sources, including news websites, publications from insurance companies, financial institution press releases and official government agencies. Economic loss totals include any available insured loss estimates, which can be found in the corresponding event text.

About Impact Forecasting

Impact Forecasting is a catastrophe model development center of excellence within Aon Benfield whose seismologists, meteorologists, hydrologists, engineers, mathematicians, GIS experts, finance, risk management and insurance professionals analyze the financial implications of natural and man-made catastrophes around the world. Impact Forecasting's experts develop software tools and models that help clients understand underlying risks from hurricanes, tornadoes, earthquakes, floods, wildfires and terrorist attacks on property, casualty and crop insurers and reinsurers. Impact Forecasting is the only catastrophe model development firm integrated into a reinsurance intermediary. To find out more about Impact Forecasting®, visit **www.impactforecasting.com**.

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