Aon Benfield
Analytics | Impact Forecasting

2016 Annual Global Climate and Catastrophe Report

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Table of Contents

Executive Summary

Global Catastrophe Losses Rise to Highest Levels Seen in Four Years

Global natural disasters in 2016 combined to cause economic losses of USD210 billion, an amount 21 percent above the 16-year average of USD174 billion. The losses were an even more robust 59 percent higher on a median basis (USD132 billion). The economic losses were attributed to 315 separate events, compared to an average of 271. The disasters caused insured losses of USD54 billion, or seven percent above the 16-year mean of USD50 billion and 37 percent higher than the median (USD39 billion). This is the highest insured loss total since 2012, and put an end to a four-year downward trend since the record year in 2011. Notable events during the year included major earthquakes in Japan; Hurricane Matthew in the United States and Caribbean; catastrophic summer flooding in China, Europe, and the United States; several extensive severe weather outbreaks in the United States; major wildfires in Canada and the United States; and drought across parts of Southeast Asia and Africa. The top three perils—flooding, earthquake and severe weather—combined for 70 percent of all economic losses in 2016. While at least 72 percent of catastrophe losses occurred outside of the United States, it still accounted for 56 percent of global insured losses. This highlights the continued protection gap in many areas around the world.

The deadliest event of 2016 was the April earthquake in Ecuador that killed at least 673 people. It is worth noting that casualties from Hurricane Matthew were in excess of 600, but unofficial death toll estimates in Haiti were as high as 1,600. A total of 16 tropical cyclones (Category 1+) made landfall globally in 2016; equal to the 1980-2015 average. Fourteen of the landfalls occurred in the Northern Hemisphere, including two in the United States. Also, 2016 ended as the warmest year ever recorded since global land and ocean temperature records began being kept in 1880. This is the third consecutive record-setting year.

The April earthquakes in Japan were the costliest single economic loss event of the year. The Japanese government estimated that damage throughout Kumamoto prefecture and neighboring prefectures had incurred an economic cost as high as USD38 billion. This was also the most expensive event for the insurance industry at USD5.5 billion.

The costliest weather event occurred in China after summer floods along the Yangtze River basin caused damage at upwards of USD28 billion. For insurers, Hurricane Matthew was the costliest weather-related catastrophe, with losses expected near USD5.0 billion.

Global economic losses in 2016 ranked as the seventh-most ever recorded and just the eighth time on record to top USD200 billion. Insured losses ranked as the sixth-most on record for the industry and just the ninth time that a year has topped USD50 billion[1].

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: **www.aonbenfield.com/catastropheinsight**

[1] An event must meet at least one of the following criteria to be classified as a natural disaster: economic loss of USD50M, insured loss of USD25M, 10 fatalities, 50 injured or 2,000 homes or structures damaged.

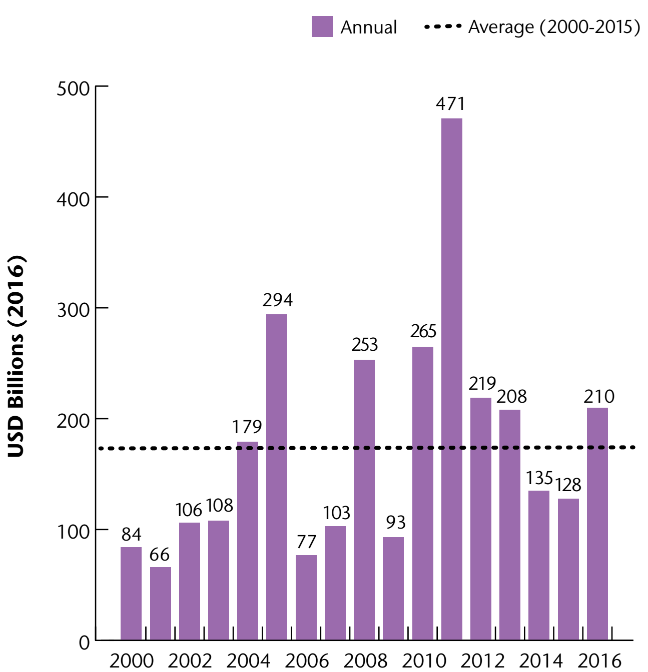
2016 Natural Disaster Events and Loss Trends

Global Economic Losses

Exhibit 1: Top 10 Global Economic Loss Events

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
April 14 & 16	Earthquake	Japan	154	38 billion	5.5 billion
Summer	Flooding	China	475	28 billion	750 million
Sept. 28 – Oct. 10	Hurricane Matthew	US, Caribbean	605	15 billion	5.0 billion
August	Flooding	United States	13	10 to 15 billion	3.0 billion
Yearlong	Drought	China	N/A	6.0 billion	200 million
May / June	Flooding	Western/Central Europe	20	5.5 billion	3.4 billion
Yearlong	Drought	India	N/A	5.0 billion	750 million
August 24	Earthquake	Italy	299	5.0 billion	100 million
July	Flooding	China	289	4.7 billion	200 million
May	Wildfire	Canada	0	4.5 billion	2.8 billion
			All other events	83 billion	33 billion
			Totals	**210 billion[1]**	**54 billion[1,2]**

Exhibit 2: Global Economic Losses: All Natural Disasters



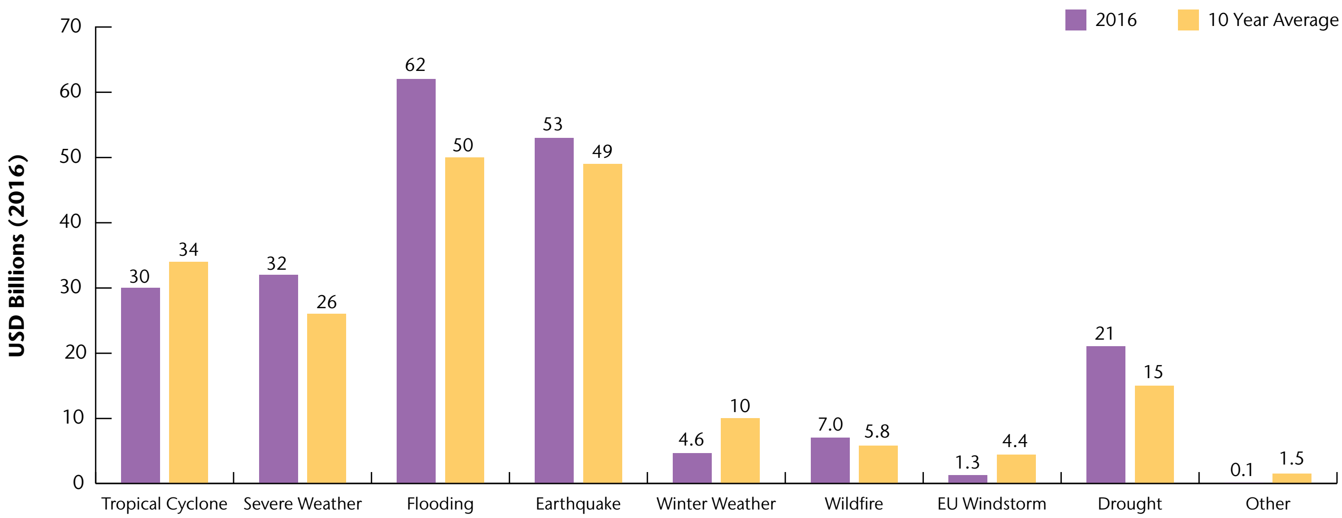
[1] *Subject to change as loss estimates are further developed*
[2] *Includes losses sustained by private insurers and government-sponsored programs*

Economic losses in 2016 were almost entirely driven by the flooding, earthquake, severe weather, and tropical cyclone perils. The four perils accounted for 85 percent of all global natural disaster losses. For the fourth consecutive year, flooding was costliest overall peril at USD62 billion, or 30 percent of the aggregated tally. See Exhibit 3 for more details. The most significant flood event was the summer flooding along the Yangtze River basin in China that left an estimated USD28 billion in damage. Additional summer flooding in northeastern China, including Beijing, cost another USD4.7 billion. The other major flood event occurred in the United States in August. Historic flooding in the state of Louisiana led to catastrophic damage in the greater Baton Rouge metro region as total losses were estimated to range between USD10 and 15 billion. However, the costliest natural disaster of the year was the series of major April earthquakes in Japan's Kumamoto prefecture. Economic losses were minimally USD38 billion.

Total economic losses were 21 percent above the 2000 to 2015 mean (USD174 billion) on an inflation-adjusted basis. On a median basis (USD132 billion), economic losses were 59 percent higher. The USD210 billion economic toll in 2016 represents the highest natural disaster loss since 2012. Economic losses have annually trended upwards by 4.0 percent above inflation, or positively trended upwards by 7.0 percent nominally, since 1980.

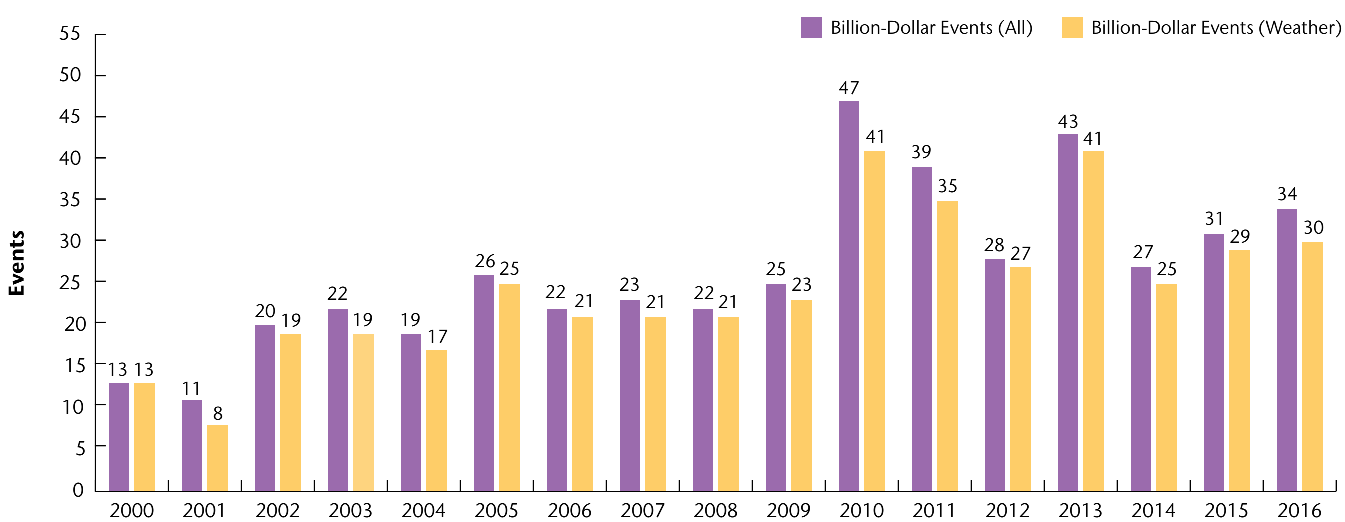
For the fourth consecutive year, the costliest peril was flood. It was 24 percent above its short-term average and driven by catastrophic events in China and the United States. Other perils that saw aggregated costs top USD25 billion during the year were earthquake, severe weather, and tropical cyclone. All major perils were above their recent 10-year averages with the exception of tropical cyclone, European windstorm, and winter weather. The earthquake peril had its costliest year since 2011 following major events in Japan, Italy, New Zealand, and Ecuador.

Exhibit 3: Global Economic Losses by Peril



There were 34 individual billion-dollar natural disaster events in 2016, well above the average of 26 dating to 2000. It was three higher than the total registered in 2015. The United States led with 14 individual billion-dollar events, while APAC was second with 13, EMEA was third with 4 and the Americas was fourth with 3. Please note that Hurricane Matthew was bucketed as a billion-dollar event in the US since the majority of losses occurred there. For weather-only events, there were 30 billion-dollar disasters, which was also above the 16-year average of 24. The tally was one higher than the total in 2015. The United States led with 14, followed by APAC (11), EMEA (3), and the Americas (2).

Exhibit 4: Global Billion-Dollar Economic Loss Events*



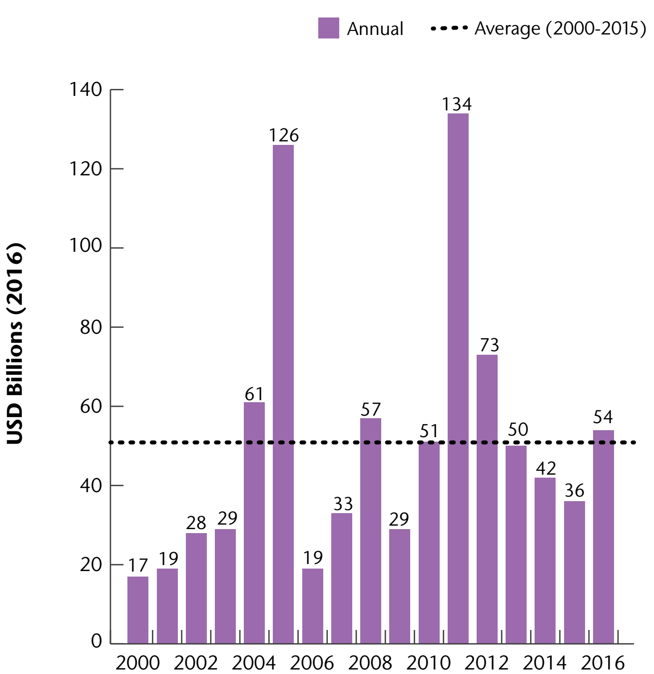
**Events have been adjusted for inflation using the 2016 U.S. Consumer Pricing Index*

Global Insured Losses

Exhibit 5: Top 10 Global Insured Loss Events

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
April 14 & 16	Earthquake	Japan	154	38 billion	5.5 billion
Sept. 28 – Oct. 10	Hurricane Matthew	US, Caribbean	605	15 billion	5.0 billion
May / June	Flooding	Western/Central Europe	20	5.5 billion	3.4 billion
April 10 – 15	Severe Weather	United States	1	4.3 billion	3.2 billion
August	Flooding	United States	13	10 to 15 billion	3.0 billion
May	Wildfire	Canada	0	4.5 billion	2.8 billion
November 13	Earthquake	New Zealand	2	3.5 billion	2.1 billion
March 22 – 25	Severe Weather	United States	0	2.5 billion	1.8 billion
April 29 – May 3	Severe Weather	United States	6	1.8 billion	1.3 billion
July 28 – 29	Severe Weather	United States	0	1.6 billion	1.1 billion
			All Other Events	118 billion	25 billion
			Totals	**210 billion[1]**	**54 billion[1,2]**

Exhibit 6: Global Insured Losses: All Natural Disasters



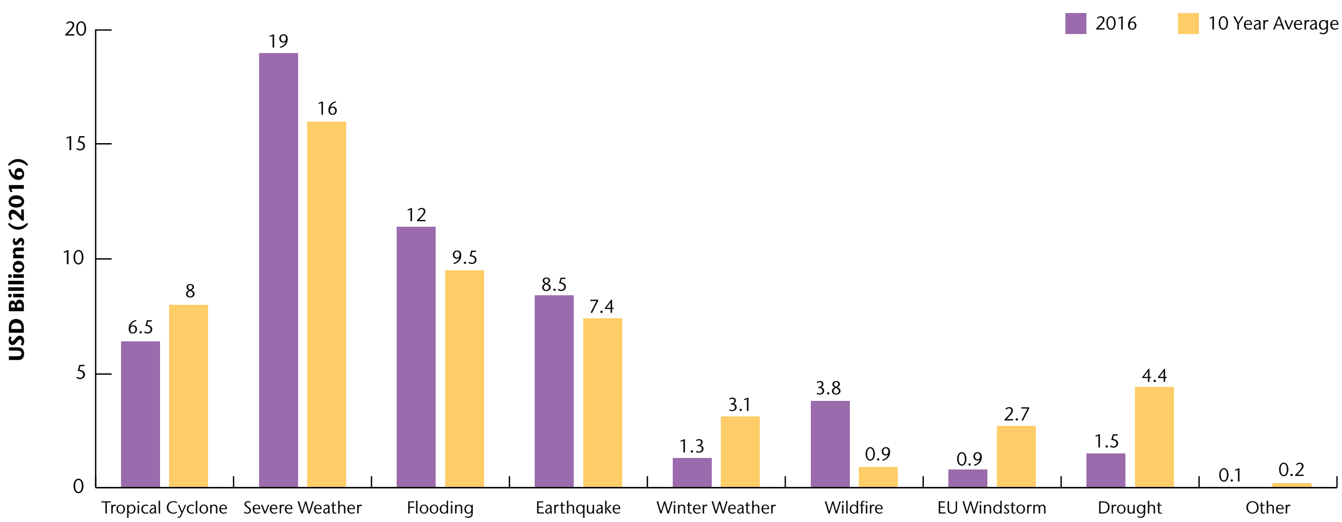
[1] *Subject to change as loss estimates are further developed*
[2] *Includes losses sustained by private insurers and government-sponsored programs*

Insured losses in 2016 were almost entirely driven by the severe weather, flooding, earthquake, and tropical cyclone perils. The four perils accounted for 85 percent of all global insured losses. For the fourth consecutive year, severe weather was costliest overall peril at USD19 billion, or 35 percent of the aggregated tally. See Exhibit 7 for more details. The costliest individual insured loss event was a series of large earthquakes that struck Japan's Kumamoto prefecture in mid-April. That event prompted an estimated USD5.5 billion insured loss. Additional notable events were Hurricane Matthew that tracked through the Caribbean and along the East Coast of the United States during September and October, an outbreak of severe weather and flooding that impacted western and central portions of Europe during May and June, and several spring and summer severe weather outbreaks in the United States. Six of the top ten insured loss events occurred in the United States. The United States incurred 56 percent of all global insured losses.

Total insured losses were seven percent above the 2000 to 2015 mean (USD50 billion) on an inflation-adjusted basis. On a median basis (USD39 billion), insured losses were much higher by 37 percent. The USD54 billion insured loss toll in 2016 represents the highest tally resulting from global natural disasters since 2012. Insured losses have annually trended upwards by 7.3 percent above inflation, or positively trended upwards by more than 10 percent nominally, since 1980.

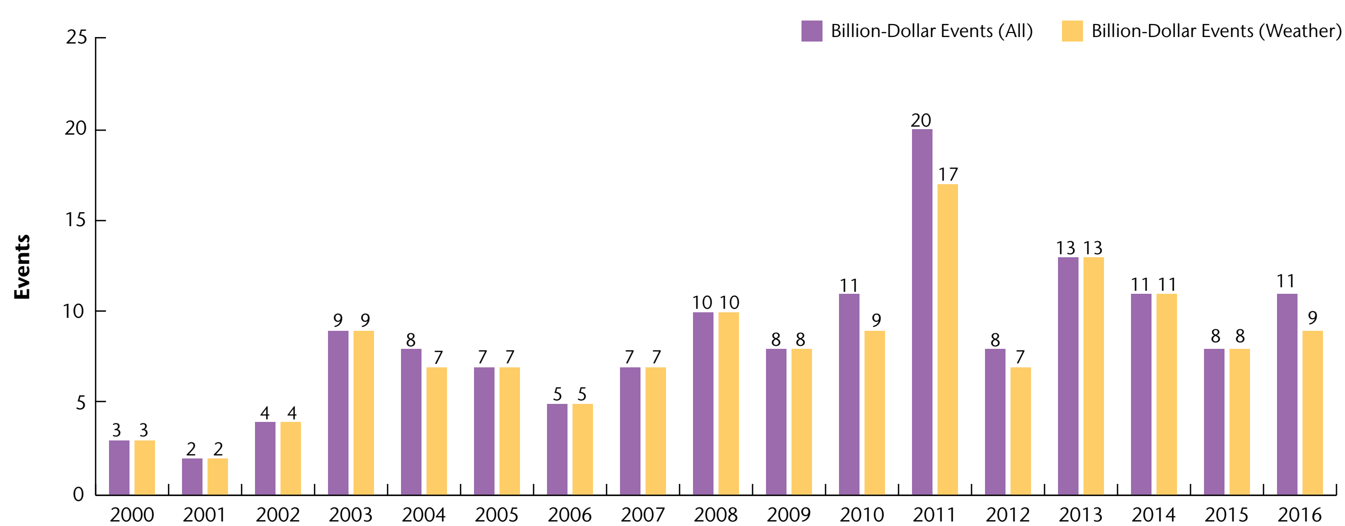
The costliest peril of 2016 was severe weather at USD19 billion, which far outpaced the next closest perils–flooding at nearly USD12 billion, earthquake at USD8.5 billion, and tropical cyclone at USD6.5 billion. All these perils, with the exception of tropical cyclone, were above their 10-year averages. The only other peril to cross its recent 10-year average was wildfire. Losses from the wildfire peril were primarily driven by Canada's Horse Creek (Fort McMurray) wildfire in May. Every other major peril incurred below normal levels of insured loss by at least 20 percent.

Exhibit 7: Global Insured Losses by Peril



There were 11 individual billion-dollar insured loss natural disaster events in 2016, above the average of 8 dating to 2000. The all-time record for billion-dollar weather events in a year is 17, which was set in 2011. The United States recorded 7 of the 11 events, with APAC recording 2 and EMEA and the Americas each having 1. There were 9 weather-related billion-dollar insured loss events, or 1 above the 16-year average. Seven of the events occurred in the U.S., while one each was noted in EMEA and the Americas. This marked the first time since 2012 that a non-weather related catastrophe crossed the billion-dollar threshold for the industry.

Exhibit 8: Global Billion-Dollar Insured Loss Events



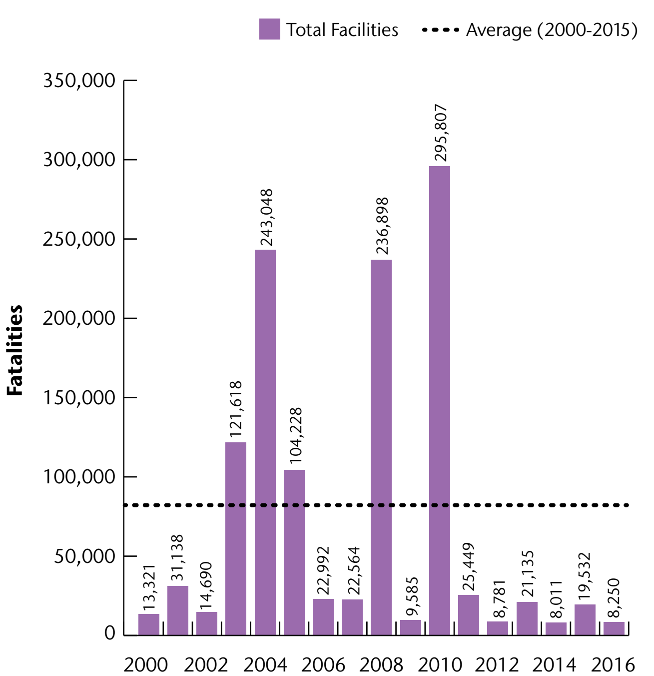
Note: Exhibit 8 includes events which reached the billion-dollar-plus (USD) threshold after being adjusted for inflation based on the 2016 U.S. Consumer Price Index.

Global Fatalities

Exhibit 9: Top 10 Human Fatality Events

Date(s)	Event	Location	Deaths	Economic Loss (USD)
April 16	Earthquake	Ecuador	673	3.4 billion
Sept. 28 – Oct. 10	Hurricane Matthew	US, Caribbean	605	15 billion
Aug. 29 – Sept. 1	Typhoon Lionrock	China, Japan, South Korea, North Korea	550	325 million
Summer	Flooding	India	484	150 million
Summer	Flooding	China	475	28 billion
April	Heatwave	India	300	N/A
August 24	Earthquake	Italy	299	5.0 billion
July	Flooding	China	289	4.7 billion
April 14 – 16	Earthquake	Japan	154	38 billion
April	Flooding	Pakistan, Afghanistan	152	Unknown
		All Other Events	~4,200	115 billion
		Totals	**~8,250**	**210 billion**

Exhibit 10: Global Human Fatalities



The number of human fatalities caused by natural disasters in 2016 was approximately 8,250. Seven of the top ten events occurred in Asia, though the deadliest event was the April earthquake in Ecuador that claimed at least 673 lives. Hurricane Matthew moved through the Caribbean and along the east coast of North America, officially claiming more than 600 lives. The highest death toll was recorded in Haiti, though unofficial estimates suggest that as many as 1,600 people perished during the cyclone. The deadliest peril of the year was flooding, comprising 42 percent of human fatalities. The deadliest flood event of the year occurred in India during July and August when at least 484 people were killed. The second deadliest peril of 2016 was tropical cyclone which comprised 27 percent of global fatalities. Aside from Hurricane Matthew, the most notable tropical cyclone was Typhoon Lionrock which prompted devastating flooding in North Korea. Other events in the top ten include major earthquakes in Ecuador, Italy, and Japan; and a pre-monsoon season heatwave in India.

2016 saw a 60 percent decrease in natural disaster-related fatalities from those sustained in 2015 with roughly 19,500, and was a substantial 89 percent lower than the average since 2000 with roughly 71,000. The tally was also well below the median number fatalities of approximately 22,550.

Natural Disasters Defined and 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/Structures Damaged: 2,000

Based on these criteria, there were at least 315 separate natural disaster events in 2016, which was 16 percent higher than the 2000-2015 average of 271. As is typically the case, the second and third quarters were the most active with 84 and 99 events occurring, respectively. Asia-Pacific incurred the higher number of overall events, which is to be expected given Asia's expansive landmass and susceptibility to natural disaster events. The United States was the second-most active region of the globe.

Exhibit 11: Total Natural Disaster Events

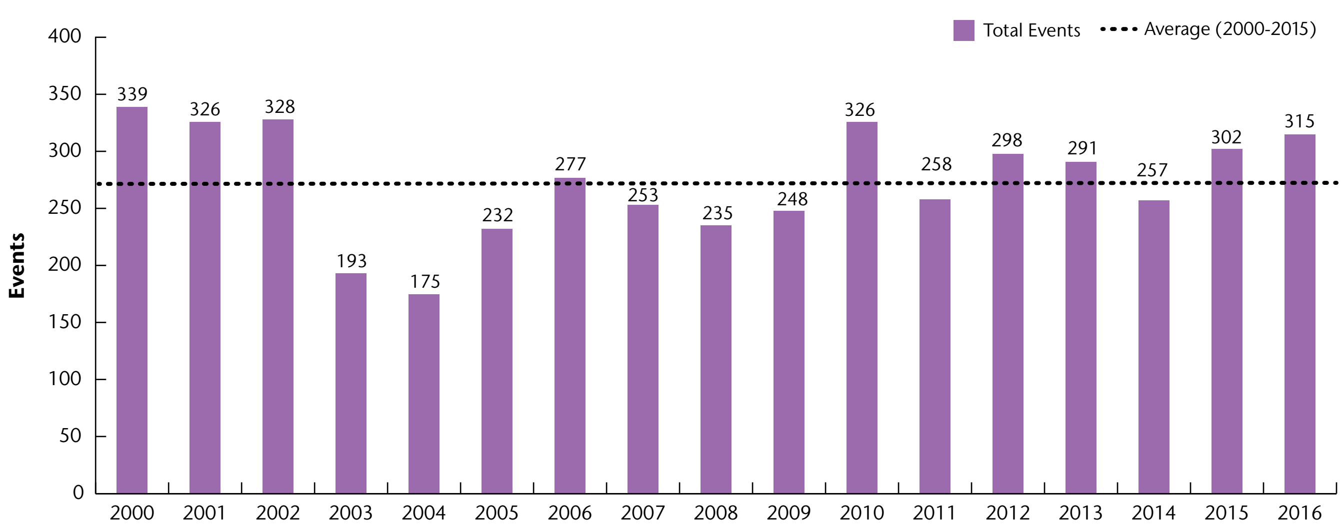
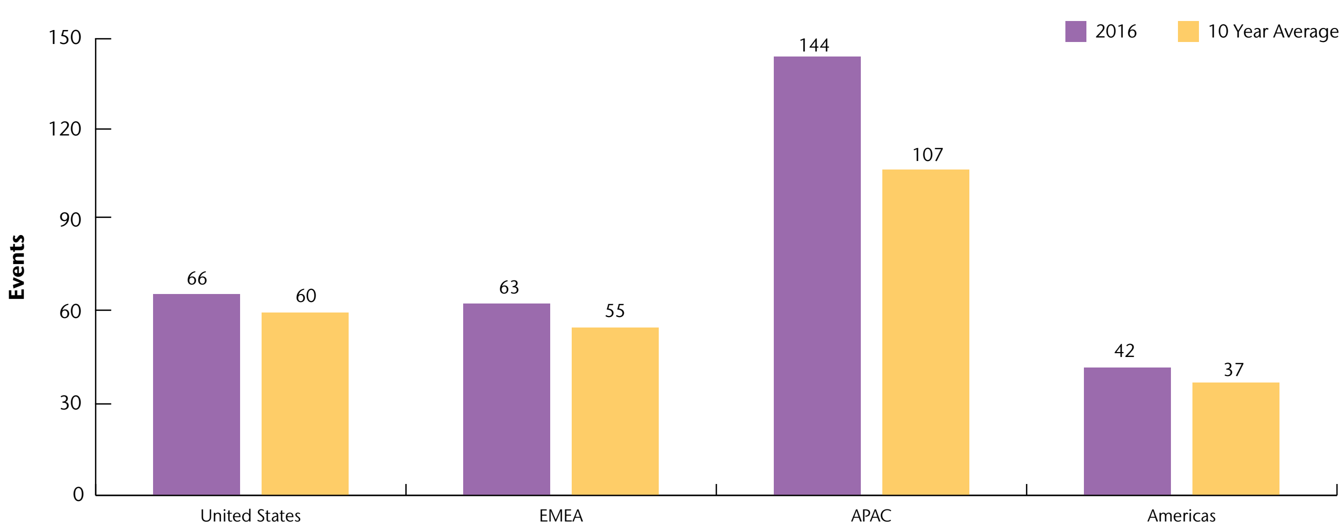


Exhibit 12: Total Natural Disaster Events by Region



Analysis

Are Annual Weather Catastrophe Losses Now Being Defined by Larger and Costlier Events?

A widely understood viewpoint suggests that global weather catastrophe losses have continued to show a growing positive trend during the past four decades. With 2016 putting an end to a four-year downturn following record losses in 2011, it raised questions as to whether this larger positive trend remains true. Other analyses have studied catastrophe losses solely in the context of Gross Domestic Product (GDP) as a primary metric to draw their own conclusions. This study takes a deeper dive into actual event data on a case-by-case basis to help better explain the evolution of catastrophe losses and whether annual losses are now being defined by larger and costlier events.

Simple Statistics: Mean and Median Analysis

Using data from Aon Benfield's extensive catastrophe loss database, a mean and median analysis was conducted using global weather events dating to 1980 that minimally caused USD50 million in economic damage and USD25 million in insurable loss. The losses have been adjusted to 2016 USD using the U.S. Consumer Price Index (CPI), which is a type of cost-of-living adjustment measure. For clarification, 1980 is often a starting point for loss analyses since this is when global weather loss datasets are considered sufficiently robust.

Based on the listed criteria, global weather mean losses for individual events on an economic loss basis have shown an annual growth rate of 1.4 percent since 1980. The peak mean during this period came in 2005 at USD3.43 billion; which is unsurprising given the series of substantial hurricane-related costs. The same 1.4 percent annual rate of growth was also found on a median basis.

Exhibit 13: Economic Loss Analysis (Weather Events)

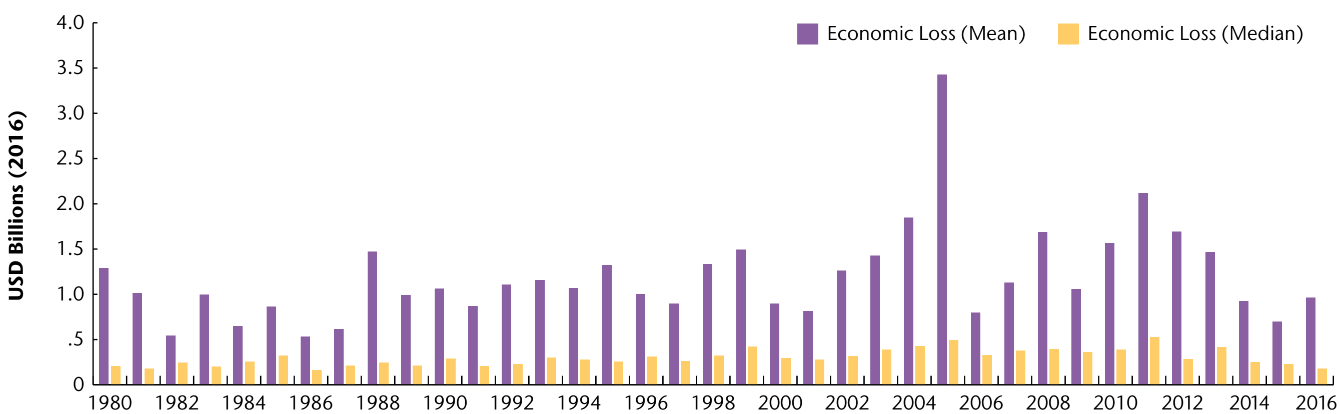
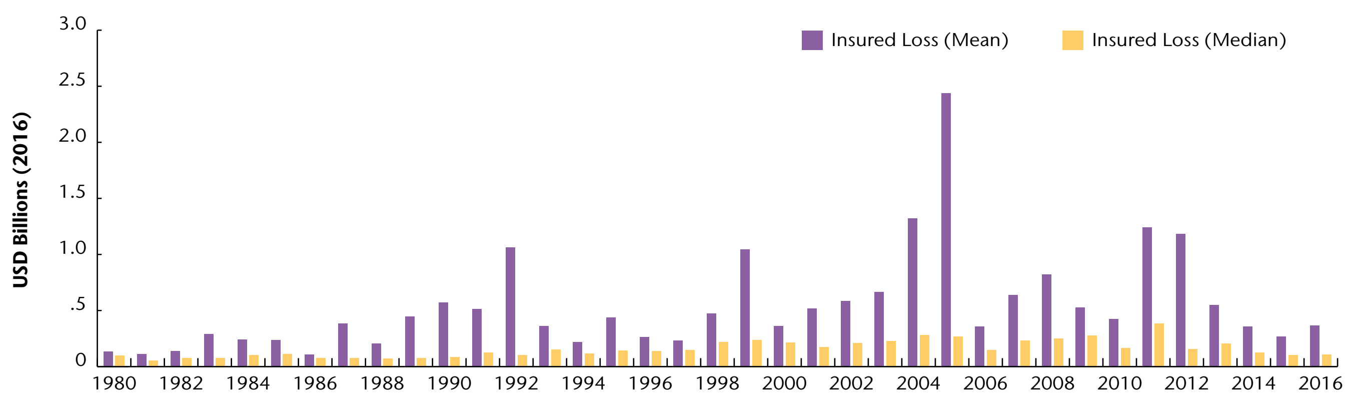


Exhibit 14: Insured Loss Analysis (Weather Events)



However, 2011 had the highest overall median cost at USD530 million due to a higher frequency of high-loss events.

The rates of growth on an insured loss basis for individual events have shown an even higher positive trend during this timeframe. Data indicates that global mean losses have annually grown at 3.8 percent. The peak mean again occurred in 2005 at USD2.44 billion–which was nearly double the second-highest year in 2004 (USD1.32 billion). A slightly less 3.0 percent growth rate was determined on a median basis. Similarly to the economic cost, the year 2011 remains the highest historically at USD380 million due to the volume of major events. It is worth noting that the rates of loss growth will be higher for insurable losses than the overall economic cost as insurance penetration continues to accelerate in maturing markets.

Billion-Dollar Events

Another key metric in trying to understand whether catastrophe events are becoming costlier is the actual frequency of high-loss events; notably in the billion and multi-billion dollar scale. These data points help indicate the overall frequency and magnitude of high-threshold events. From an economic loss perspective, the globe has averaged 19 billion-dollar weather events and 10 multi-billion dollar events since 1980. Yet there has been a noticeable uptick in the number of such events in recent years as the decadal average of billion-dollar events has increased from 10 (1980-1989) to 32 (2010-Present).

From an insured loss perspective, the event frequency rate of growth has been even more significant. Not until 1990 did annual tallies begin to regularly record billion-dollar loss events for the insurance industry. The long-term average since 1980 is five, but since 2000, that average has increased to eight. Each of the top five years have occurred in the last decade, including the record 17 in 2011. A similar trend is found for multi-billion dollar events. After averaging less than one such event a year during the 1980s, the industry now averages four per year during the last decade.

Exhibit 15: Global Billion-Dollar Economic Loss Weather Events*

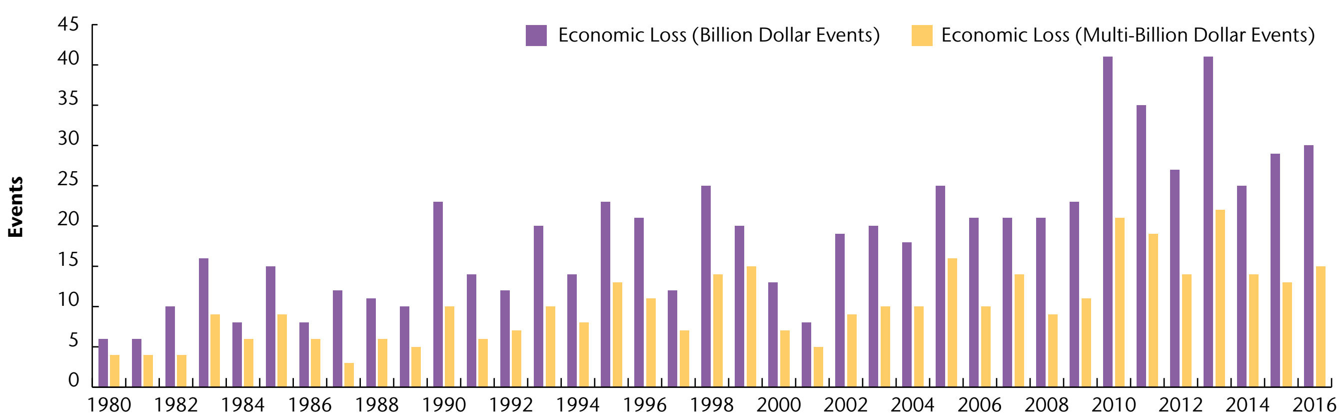
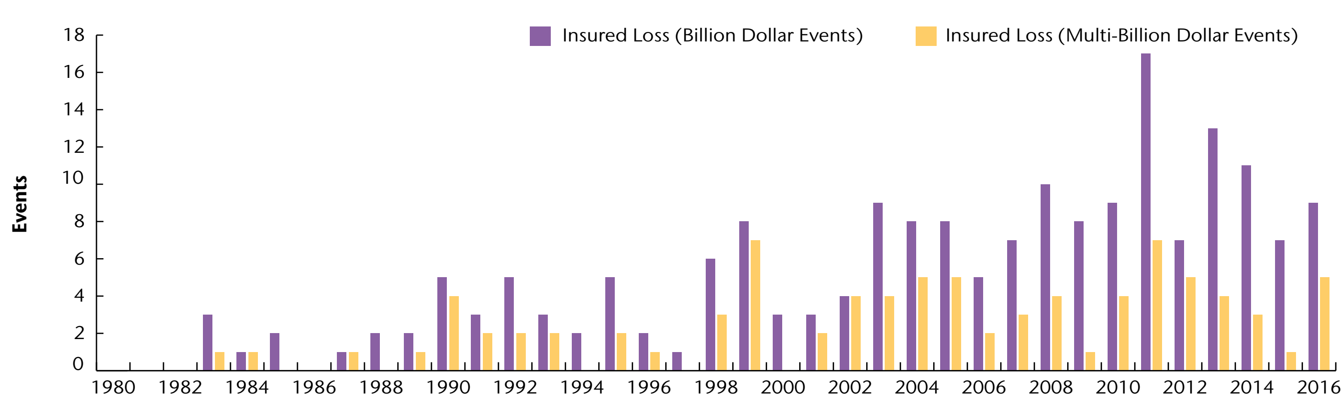


Exhibit 16: Global Billion-Dollar Insured Loss Weather Events*



Events have been adjusted for inflation using the 2016 U.S. Consumer Pricing Index

As mentioned previously, it is largely expected that from an insurance perspective the amount of losses will continue to grow with the further emergence of take-up rates in developing countries all around the world.

Loss Drivers: Contributing Factors to Increase

There are many factors that can be attributed to these loss increases. With continued scientific data highlighting the presence of climate change, there is growing evidence of how a warming atmosphere is leading to sea level rise, more unusual weather patterns and intense meteorological events that are beyond what has been recorded historically.

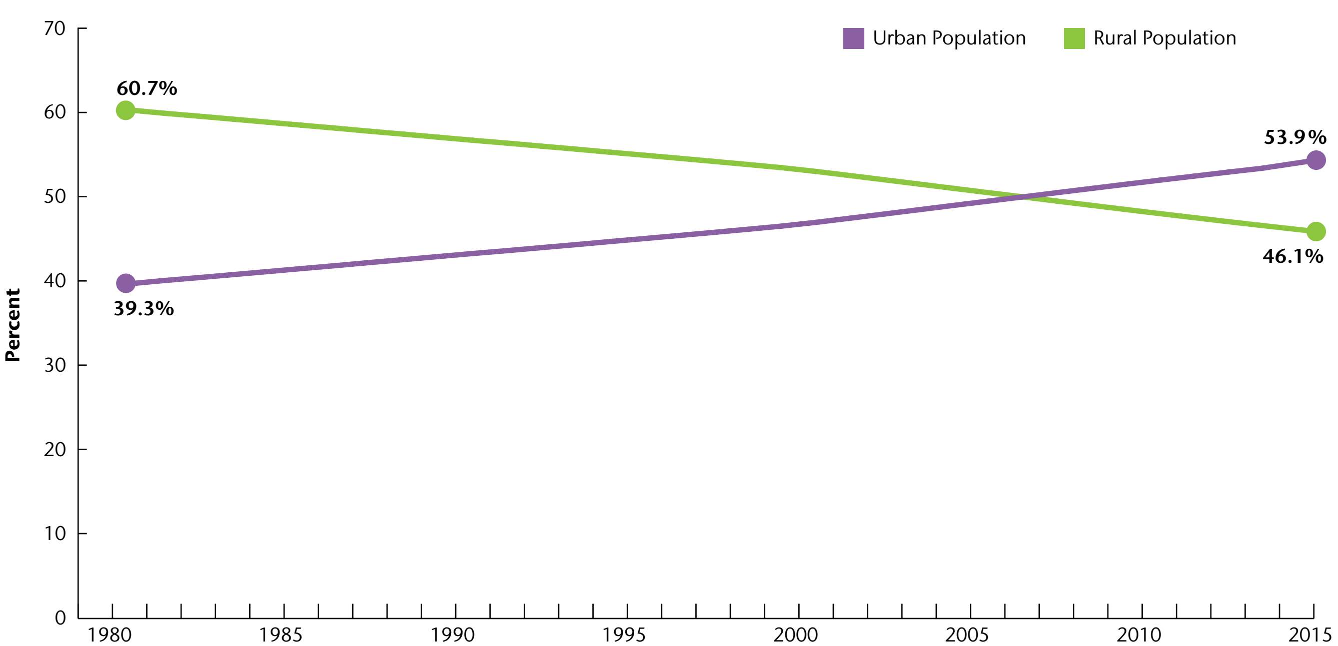
An equally important contributing component involves global population and migration patterns. Since 1980, global population has risen at a compound average growth rate (CAGR) of 1.4 percent to 7.4 billion in 2015. An even more noteworthy statistic is that the percentage of urbanized population has grown by 0.9 percent each year to 53.9 percent. The United Nations (UN) anticipates this percentage to grow to 66 percent by 2050. Perhaps the most important population metric surrounds migration, as the UN suggests that by the next census study in 2020, roughly half of the world's population will live within 100 kilometers of an ocean coastline. All of these factors translate to a greater concentration of people–and higher volume of exposures–situated in some of the most vulnerable locations on the planet.

Concluding Remarks

When analyzing the catastrophe losses on a mean and median basis, plus the actual count of the costliest events in the billion-dollar range, it can be concluded that there has been an increase in both annual and individual weather disaster costs in the last nearly four decades. It can reasonably be assumed that the combination of effects from climate change, more intense weather events, greater coastal exposures and population migration patterns are all equal contributors to the loss trend.

With all of these parameters in place, and all forecasts continuing to signal greater risk and vulnerability, it is anticipated that weather-related catastrophe losses will additionally increase in the coming years.

Exhibit 17: Percentage of Rural and Urban Population

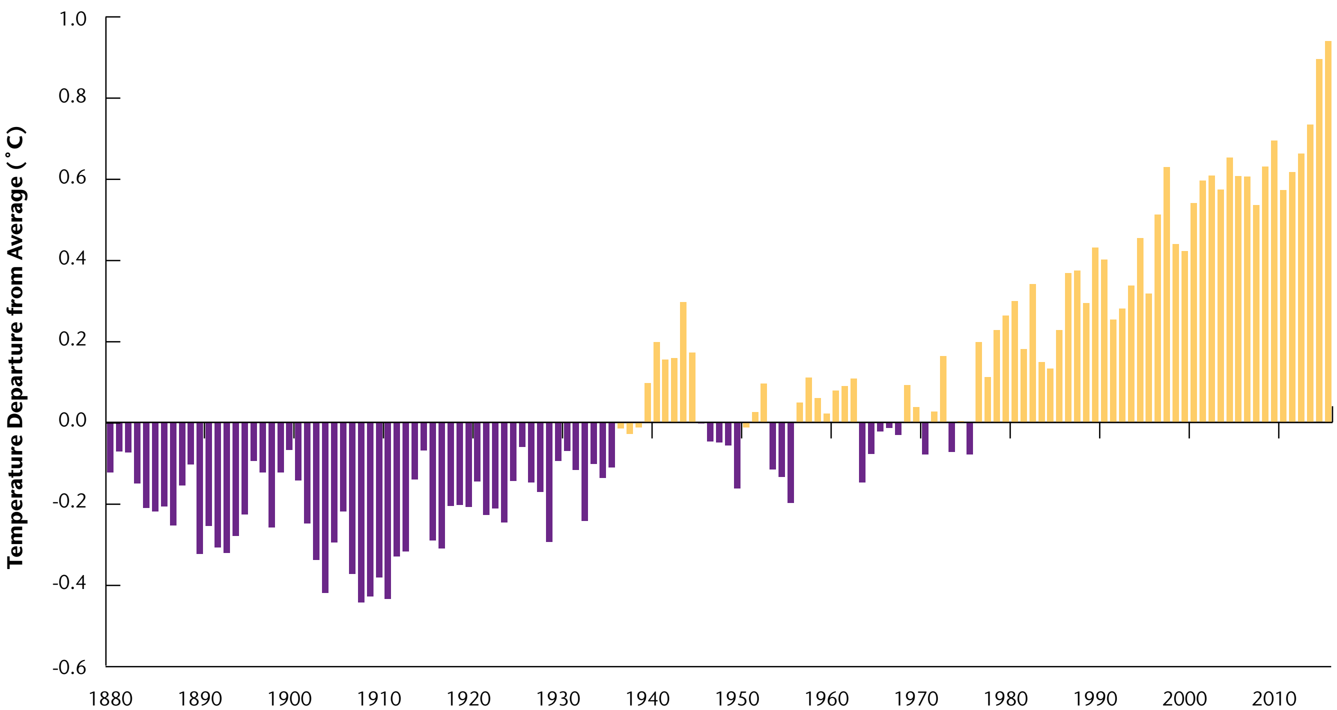


Source: World Bank

2016 Climate and Natural Peril Review

2016 was the 40th consecutive year of above average global temperatures. Using official data provided by the National Centers for Environmental Information (NCEI) – formerly known as the National Climatic Data Center (NCDC)–combined land and ocean temperatures for the earth averaged 0.94°C (1.69°F) above the long-term mean, making 2016 the warmest year ever recorded since official data on global temperatures began being collected in 1880. This surpasses the previous record of 0.89°C (1.60°F) that was set in 2015. It also became the third consecutive year of the globe establishing a new temperature record for heat. The anomaly data is used in conjunction with NCEI's 20th century average (1901-2000). The last below-average year for the globe occurred in 1976, when global temperatures registered 0.08°C (0.14°F) below the long-term average.

Exhibit 18: Global Land and Ocean Temperature Anomalies



Source: NOAA

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), 2016 was a year initially marked by the end of one of the strongest El Niño phases on record. El Niño was quick to dissipate early in the year, which was followed by a quick transition to weak La Niña conditions by the end of the calendar year. El Niño officially ended in May as sea surface temperature anomalies in the equatorial Pacific dropped below the 0.5°C threshold. This meant that El Niño was officially in place from November 2014 to May 2016. Continued cooling persisted and a La Niña was declared during the boreal fall season. Long-range forecasts indicate that La Niña should weaken or dissipate during the first quarter of 2017 and ENSO-neutral conditions will linger into the middle of the year.

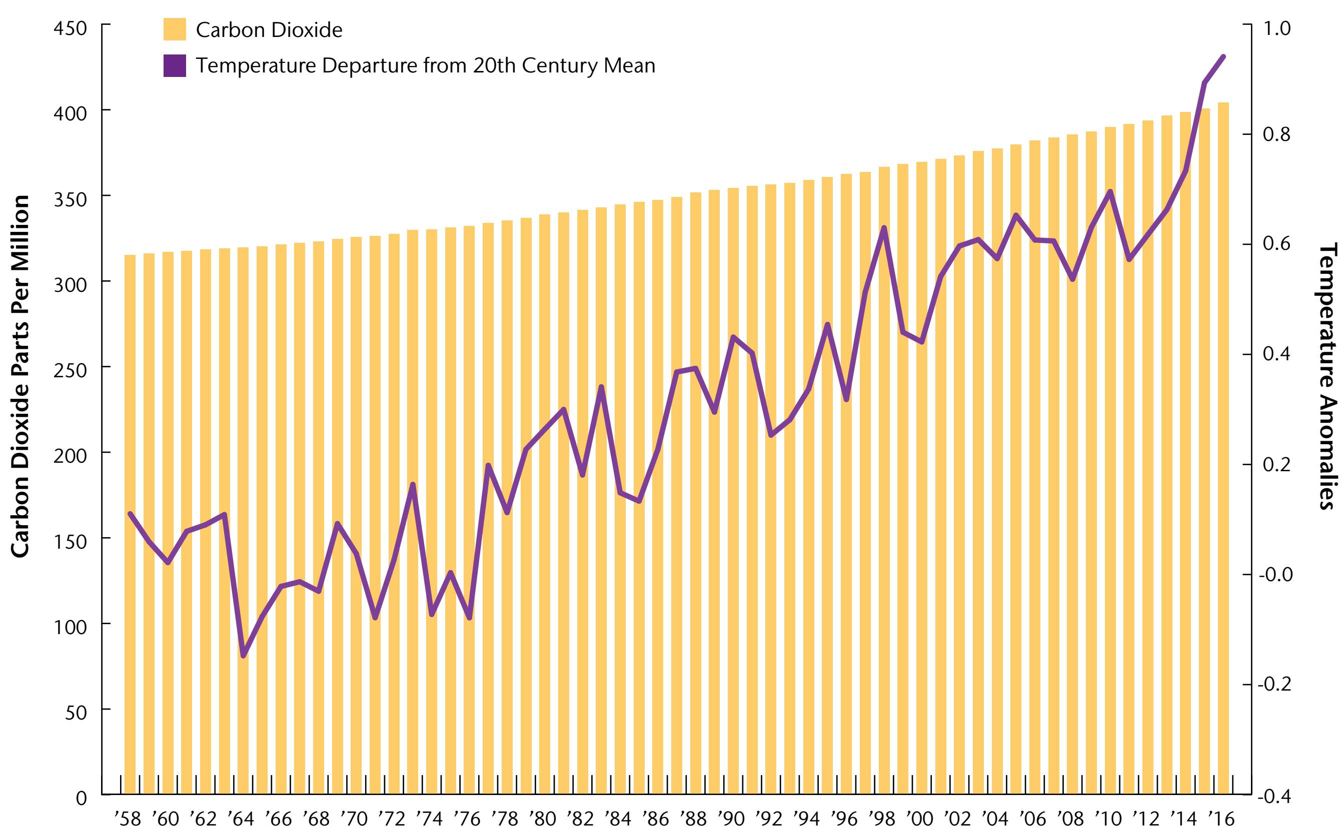
Global Carbon Dioxide

2016 marked the first year since 1958 (when instrumentally-recorded measurements began) that monthly averaged atmospheric carbon dioxide levels did not drop below 400 parts per million (ppm). Using data provided by the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory (ESRL), global carbon dioxide levels averaged 404 ppm in 2016 – a rise of three ppm over the 2015 annual average. The highest monthly average concentration of 408 ppm was observed in May; while the lowest monthly average concentration of 401 ppm was recorded in September. May's concentration of 408 ppm was the highest value ever recorded.

Atmospheric carbon dioxide levels have a scientifically proven correlation with global temperature: data from ice cores and geological records show that as atmospheric concentrations of carbon dioxide increase, temperatures rise. The opposite is also true; as atmospheric concentrations of carbon dioxide decrease, temperatures fall. This was seen during the last several ice ages. It is important to highlight that the concentration of atmospheric carbon dioxide levels fluctuate throughout the year, correlating with Northern Hemisphere seasons. 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.

Carbon dioxide 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.

Exhibit 19: Global Annual Average Atmospheric Carbon Dioxide Concentrations: 1958-2016



Source: NOAA

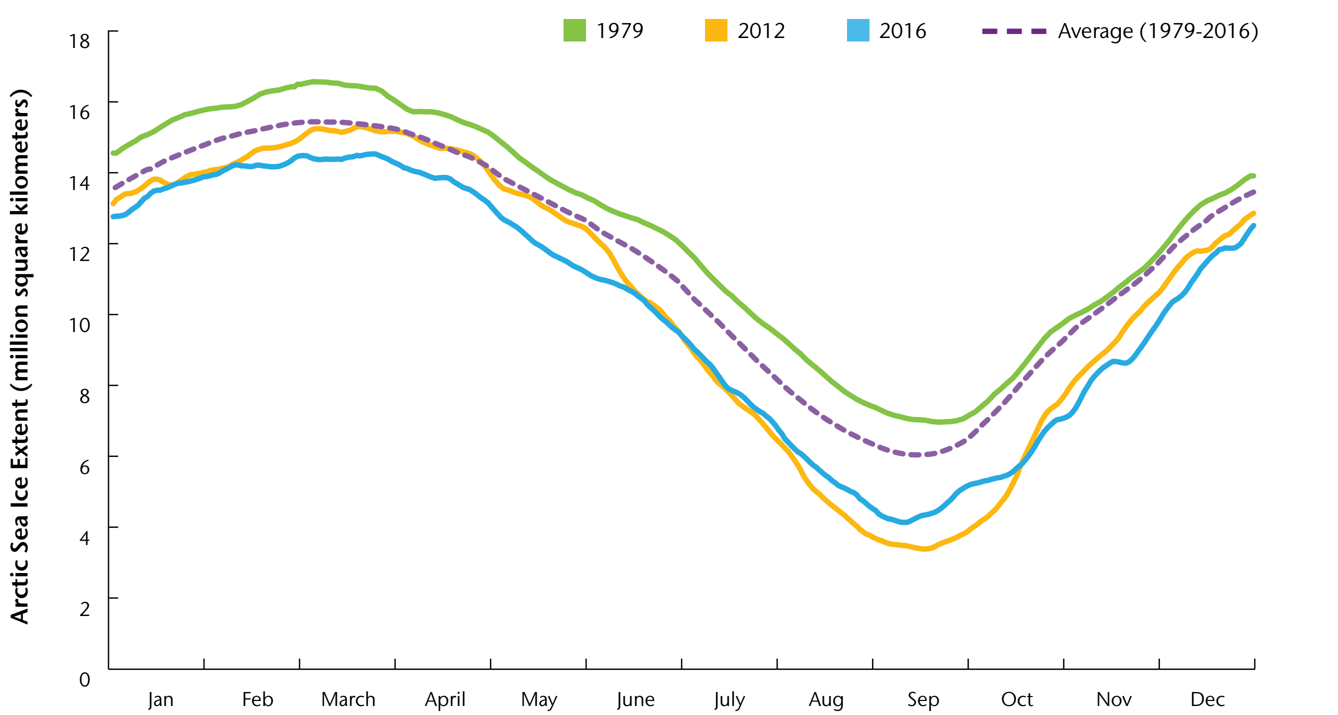
Arctic Sea Ice

The decline of Arctic sea ice has been well documented and is regarded as one of the most visible signs of a warming atmosphere during the past few decades. Arctic sea ice, which is of vital importance to a number of Arctic animals, also plays a significant role in climate regulation. It influences exchanges of heat, moisture and salinity in the Arctic Ocean, as it insulates the relatively warmer ocean waters from the cold atmosphere. There are several feedback mechanisms that come into the process. For example, open water absorbs more solar energy than highly-reflective ice does, which further exacerbates melting.

Like carbon dioxide concentrations, the spatial extent and area of sea ice, thickness and age can vary significantly in response to meteorological conditions, as well as long-term changes in climate, resulting from man-made or natural processes. Arctic sea ice extent changes seasonally, with a minimum in September and maximum in late winter. Sea ice decline has been connected to rising global temperatures, and the Arctic in particular is a region that has seen some of the most rapid temperature increases during the past three decades. It is generally agreed within the scientific community that increased greenhouse gas concentrations contribute largely, but not wholly, to the rapid decline of Arctic sea ice. September minimum extent has been decreasing by about 85,000 km^2 (33,000 mi^2) annually since 1979. However, since the mid-1990's, the Arctic has seen a much sharper decline of about 125,000 km^2 (45,000 mi^2) every year.

In 2016, extraordinary meteorological conditions resulted in further decline of the Arctic sea ice. An historical minimum of 3.41 million km^2 (1.32 million mi^2) recorded September 2012 was not reached last year. However, in 2016 the minimum extent of 4.14 million km^2 (1.6 million mi^2) tied with the second lowest minimum on satellite record dating to 2007. The slow rate of ice growth observed during the second half of the year was unprecedented as November and December 2016 monthly minimums were the lowest on record and new daily minimum records were set for the whole period from October 18 to December 31. Several major setbacks were recorded, the largest in mid-November in the middle of the growth season, when the extent dropped by approximately 50,000 km^2 (19,000 mi^2) in three days. Sea ice extent in the first half of 2016 was also far below average and the maximum of winter season 2015/2016, reached in March 2016, tied with the record low for winter maximum ice extent, set in February 2015.

Exhibit 20: Arctic Sea Ice Extent



Source: NSIDC

Global Tropical Cyclone Activity

Overall global tropical cyclone activity in 2016 saw a downtick from last year with 88 named storms having developed across all global basins. This was slightly higher than the long-term 36-year average. There were 44 hurricanes, typhoons, and cyclones (storms with sustained wind speeds of at least 74 mph (119 kph)), which was six percent below the 36-year average of 47 and the lowest annual total since 2013. The number of major storms (Saffir-Simpson Hurricane Wind Scale rating of Category 3, 4, or 5 with sustained wind speeds of at least 111 mph (179 kph)) was 25, or one above the long-term average of 24. This was also the lowest number of such storms since 2013.

In terms of global landfalls, 16 storms came ashore in 2016 at Category 1 strength or above. Eight of those made landfall at Category 3 strength or above. Landfall averages (1980-2015) include 16 Category 1+ and five Category 3+ events. Six of the Category 3+ storm landfalls were in the Western North Pacific basin while one each was recorded in the Atlantic basin and Southern Hemisphere region.

All official tropical cyclone data comes via the U.S. National Hurricane Center (NHC) and the Joint Typhoon Warning Center (JTWC).

Exhibit 21: Global Tropical Cyclone Activity

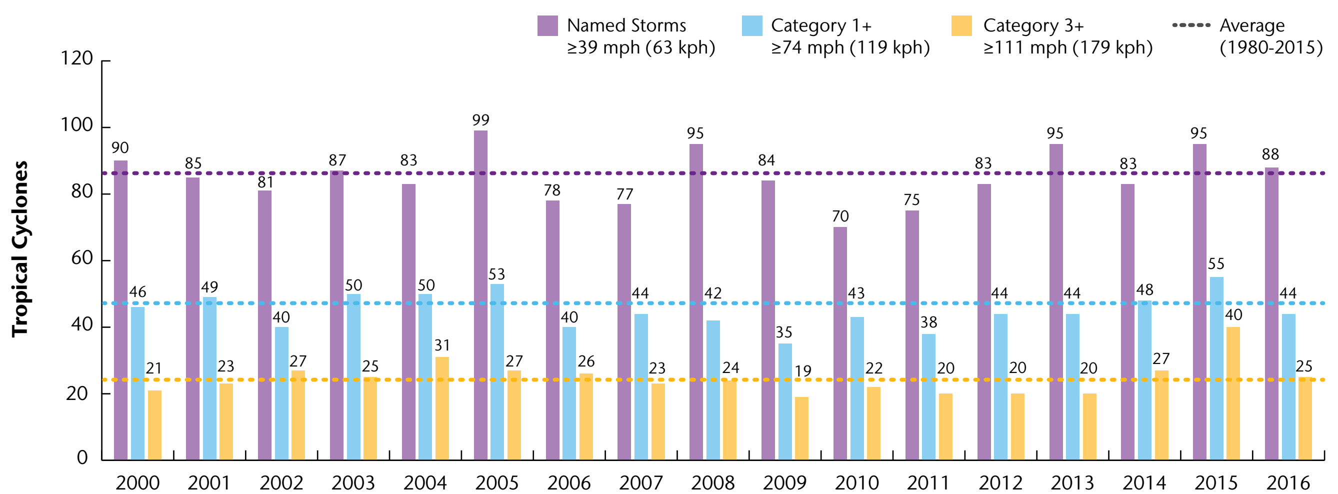
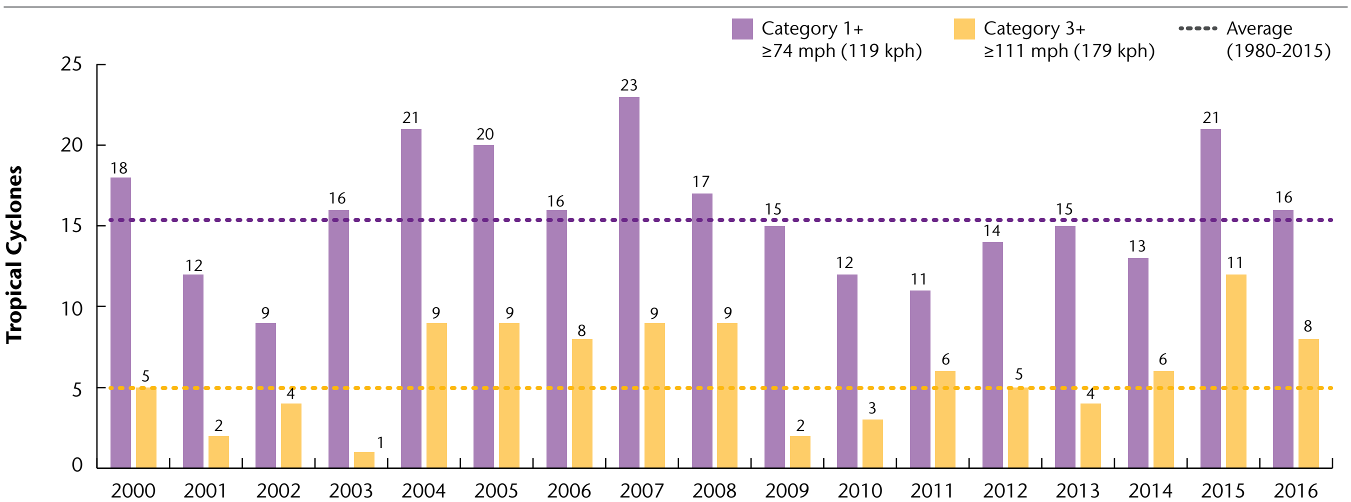


Exhibit 22: Global Tropical Cyclone Landfalls



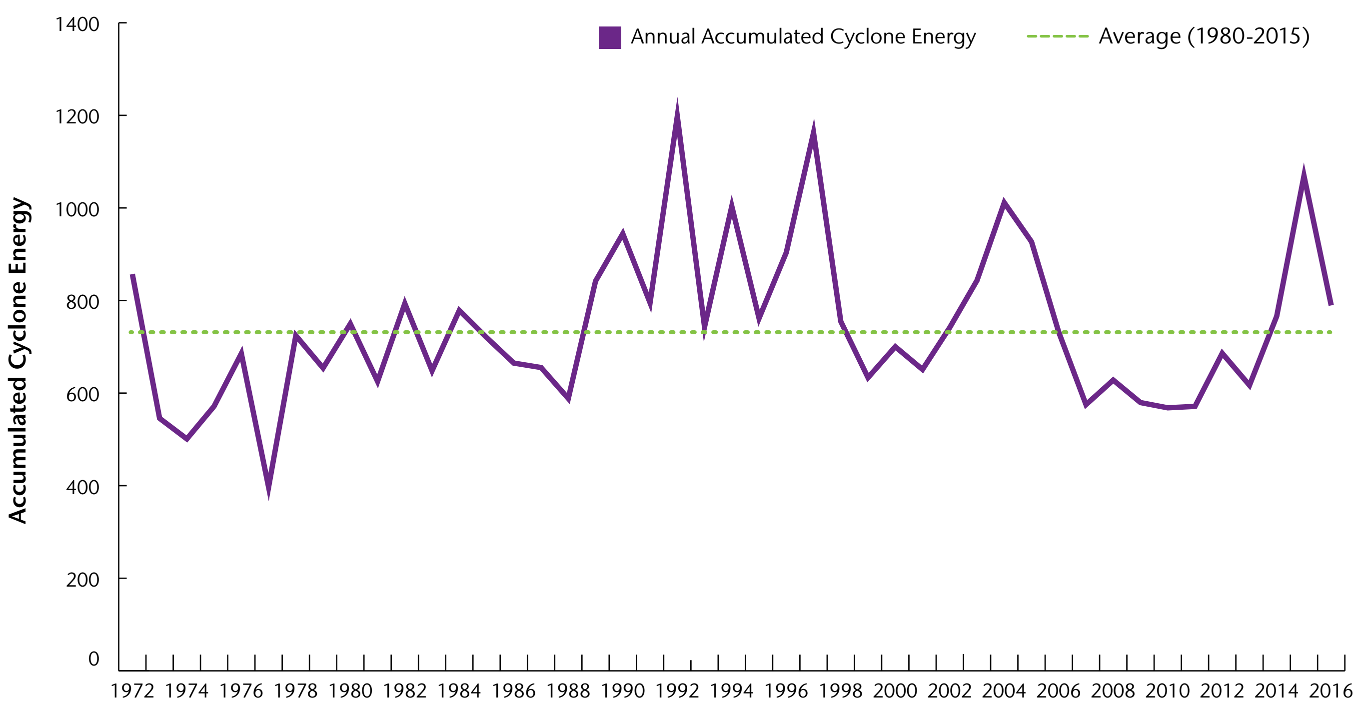
Global Accumulated Cyclone Energy

A different measure used to gauge the activity of individual tropical cyclones and tropical cyclone 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 in order 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 ACE is recorded 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 2016 was 782.8, or 15 percent higher than the recent 10-year average of 683.1. It was also higher than the long-term average from 1980-2015 of 767.6. However, it was substantially lower than 2015's total of 1,069.3 which was the highest recorded since 1997. The record year for ACE was 1992 when a value of 1,197.9 was recorded. The Atlantic and South Pacific basins were both higher than average, contributing 17 percent and 14 percent respectively to the global total primarily due to the intensity and longevity of both Hurricane Matthew and Cyclone Winston.

Exhibit 23: Global Accumulated Cyclone Energy



Source: Colorado State University

Atlantic Ocean Hurricane Season Review

The 2016 Atlantic Hurricane Season was the most active since 2012 and it marked a record 11th consecutive season in which the United States did not sustain a major hurricane landfall (Category 3+). However, two hurricanes did make landfall in the United States (Hermine and Matthew), both at Category 1 intensity, which was the most in one season since 2008. In terms of overall basin activity, it was an above average year as 15 named storms developed. This was 25 percent above the long-term average of 12. Seven hurricanes were recorded, of which three strengthened into major hurricanes. The 1980 to 2015 average number of hurricanes (Category 1+) is six, while the long-term average for major hurricanes (Category 3+) is three. The 2005 season continues to hold the record for most hurricanes in a year when 15 formed.

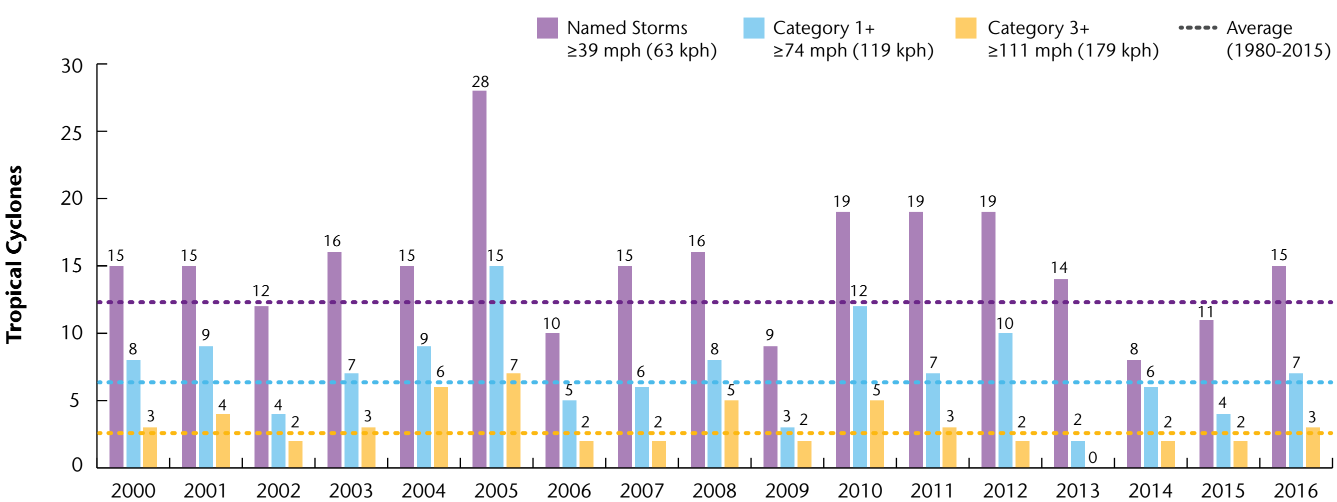
The enhanced activity in the Atlantic Basin was influenced by weak La Niña conditions that developed in the Pacific Ocean during the second half of the year. The weak La Niña event brought weaker than normal vertical wind shear and above average sea surface temperatures to the Atlantic Ocean's main development region and the Caribbean Sea.

The 2016 Atlantic Hurricane Season began unseasonably early with Hurricane Alex which developed in mid-January. Alex was the first January hurricane in the Atlantic since 1955's Hurricane Alice. Alex made landfall in the Azores as a tropical storm strength system. Tropical Storm Bonnie followed in late-May, making landfall as a tropical depression over South Carolina. Other systems to make landfall were Tropical Storm Colin (Florida), Tropical Storm Danielle (Mexico), Hurricane Earl (Mexico), Hurricane Hermine (Florida), Hurricane Matthew (Haiti, Cuba, South Carolina), and Hurricane Otto (Nicaragua).

The most notable storm of the season was Hurricane Matthew in September-October, which was the deadliest and costliest storm in the basin in 2016. Matthew officially claimed more than 600 lives in the Caribbean and United States and left an economic damage bill of USD15 billion. The worst of the storm's impacts were felt in Haiti where the vast majority of the casualties were reported. Numerous towns and villages were decimated in southwestern Haiti where approximately 200,000 homes were damaged or destroyed. Significant damage was also sustained in eastern Cuba. Matthew also caused major storm surge, inland flood and wind damage throughout coastal regions of Florida, Georgia, South Carolina, and Virginia. The state of North Carolina was particularly impacted by severe riverine flooding.

The Atlantic Hurricane Season officially runs from June 1 to November 30. For additional Atlantic Ocean Basin landfalling tropical cyclone data (including U.S.-specific information), see Appendix D.

Exhibit 24: Atlantic Basin Tropical Cyclone Activity



Eastern & Central Pacific Ocean Hurricane Season Review

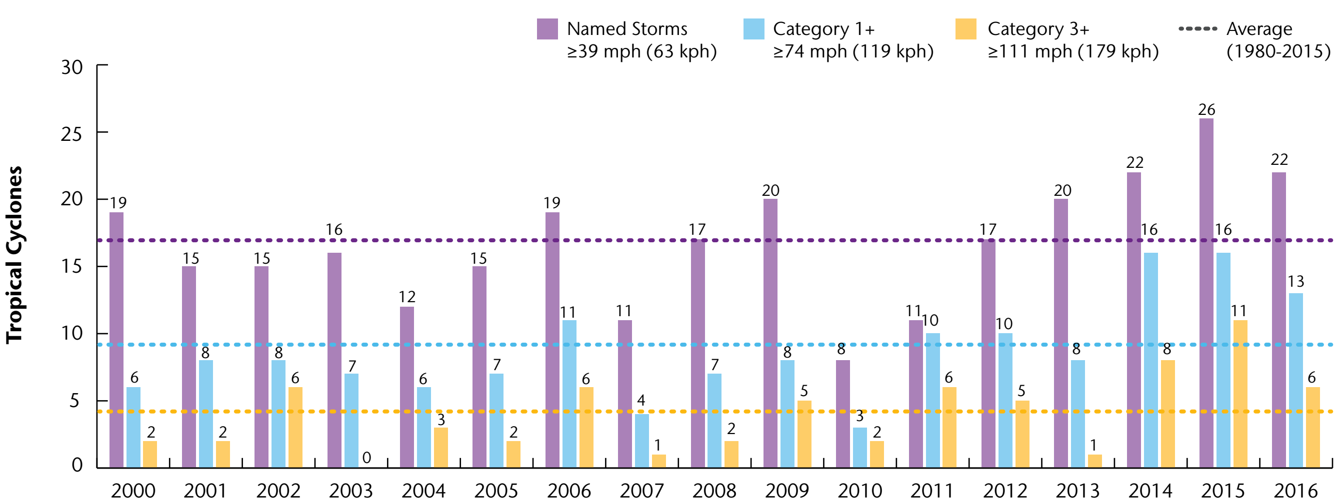
The 2016 Eastern and Central Pacific Hurricane Season was the fourth consecutive season of above average cyclone activity with a combined total of 22 named storms forming, approximately 29 percent above the 1980 to 2015 average of 17 named storms. Of the 22 named storms, 13 became hurricanes, which was roughly 40 percent above the 36-year average of nine. This was slightly below the 2015 total of 16 hurricanes. Six hurricanes strengthened to major hurricane (Category 3+) status, or one-third above the longer term average of five. Despite the enhanced hurricane activity, only one hurricane made a direct landfall: Hurricane Newton came ashore on Mexico's Baja Peninsula in September as a Category 1 strength storm.

The increased activity in the Eastern and Central Pacific Ocean in 2016 was influenced by El Niño conditions that were present in the Pacific Ocean during the first half of the year. El Niño brought higher-than-average sea surface temperatures, reduced vertical wind shear and lower atmospheric pressure to the Eastern Pacific Ocean. These factors combined to create favorable conditions for cyclogenesis.

Despite just one hurricane officially making landfall, the Eastern and Central Pacific Hurricane Season was meteorologically very active. The season got off to an early start with the formation of Hurricane Pali in January: the earliest named storm on record to form in the basin, surpassing the previous record set by 1989's Tropical Storm Winona, and the earliest hurricane to form since 1992's Hurricane Ekeka. The season became active in July with the formation of eight named storms, five of which became hurricanes and three major hurricanes (Category 3+). The season remained active through August and September with the formation of a further 10 named storms: six of which became hurricanes and two that strengthened to major hurricane status. Through the remainder of the season, a further three named storms were active in basin including Tropical Storm Otto which entered the basin from the Atlantic after causing significant damage in Central America. The most substantial cyclone event was September's Hurricane Newton which made two separate landfalls in western Mexico - both at Category 1 intensity. The first was near Cabo San Lucas and the second was over a sparsely populated region of Sonora state.

The Eastern Pacific Hurricane Season officially runs from May 15 to November 30, while the Central Pacific season runs from June 1 to November 30. For additional Eastern Pacific Ocean Basin landfalling tropical cyclone data, please see Appendix D.

Exhibit 25: Eastern and Central Pacific Basin Tropical Cyclone Activity



Western North Pacific Ocean Typhoon Season Review

Tropical cyclone activity in the Western North Pacific Ocean was close to average in 2016. A total of 26 named storms developed, which was equal to the 36-year average. Of those storms, 13 became typhoons. This was below the longer-term average of 16 typhoons. Eleven of the 13 typhoons reached Category 3 (or higher) strength, or 44 percent above the average of nine. The total of 11 typhoons attaining Category 3+ intensity was substantially lower than the 16 in 2015. Eight typhoons made landfall, which was equal to the long-term average. Six of the typhoons were Category 3 or higher in intensity at the time of landfall.

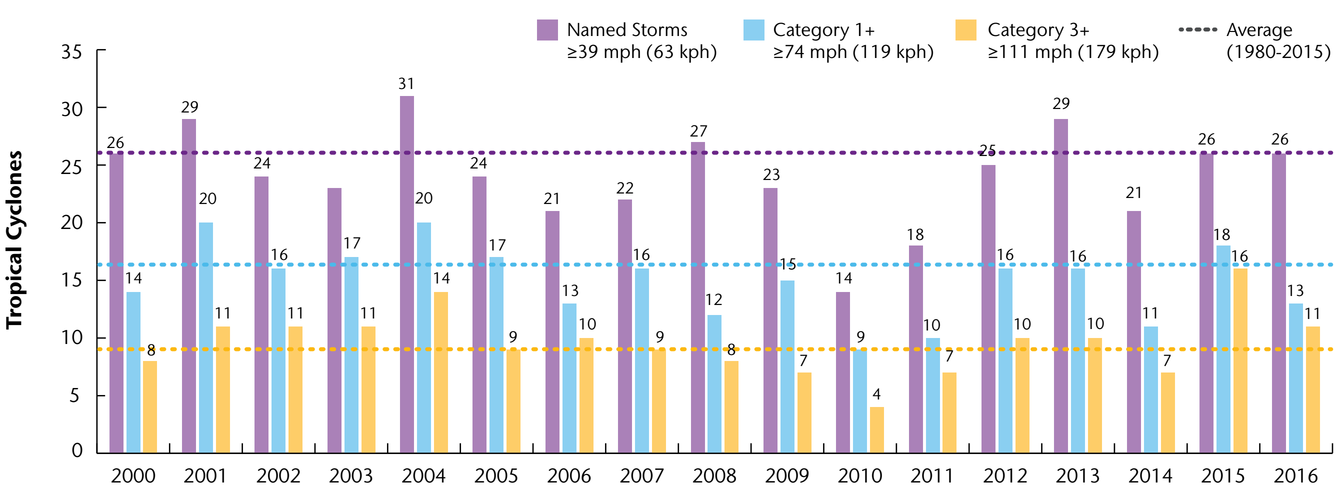
The season got off to a slow start – the fifth latest start in the satellite-era. The first named storm did not form until July, but it was the first to develop in quick succession. Three typhoons prompted USD1.0+ billion dollar economic losses during the season including most notably Super Typhoons Nepartak, Meranti, and Chaba. The bulk of the losses were incurred in China (Nepartak and Meranti), Taiwan (Nepartak and Meranti), and South Korea (Chaba). The same three typhoons were also the costliest insured storms; while the deadliest was Typhoon Lionrock which claimed an estimated 550 lives due to extensive flooding it produced in North Korea and Japan.

Several countries experienced busy periods of tropical cyclone activity during the season: Japan in August-September; Taiwan in September; and Vietnam in September-October. During August and September, Japan was impacted by no fewer than 10 tropical cyclones, the most destructive of which was September's Typhoon Lionrock. During the month of September, Super Typhoon Meranti grazed Taiwan's southwestern coast at Category 5 intensity; Typhoon Malakas passed close to the country's east coast at Category 2/3 intensity; then Typhoon Megi made landfall at Category 3 intensity. Finally, in September-October, Tropical Storms Rai and Aere made landfall in central Vietnam prompting widespread and damaging floods. Super Typhoon Nock-ten made landfall in the Philippines on Christmas Day.

The strongest typhoon of the season was September's Super Typhoon Meranti which attained Category 5 strength with sustained wind speeds of 305 kph (190 mph). Meranti was one of four typhoons to reach Category 5 intensity in the basin in 2016 and was the strongest typhoon in the Western North Pacific since 2013's Super Typhoon Haiyan. Meranti was the strongest tropical cyclone to develop anywhere across the globe in 2016.

The Western Pacific Typhoon Season officially runs throughout the calendar year, though most activity occurs between the months of May and November. For additional Western Pacific Ocean Basin landfalling tropical cyclone data, please see Appendix D.

Exhibit 26: Western Pacific Basin Tropical Cyclone Activity



North Indian Ocean Cyclone Season Review

The North Indian Ocean Basin saw minimal tropical cyclone activity in 2016. Just four named storms developed in the region which is 20 percent below the 1980 to 2015 average of five. Just one of these storms intensified to cyclone status - December's Cyclonic Storm Vardah. Based on the 36-year average, approximately two cyclones (Category 1+) develop per year and one cyclone strengthens to Category 3+ intensity. Two of the named storms made landfall as tropical storm strength systems and one made landfall at Category 1 intensity (Cyclonic Storm Vardah).

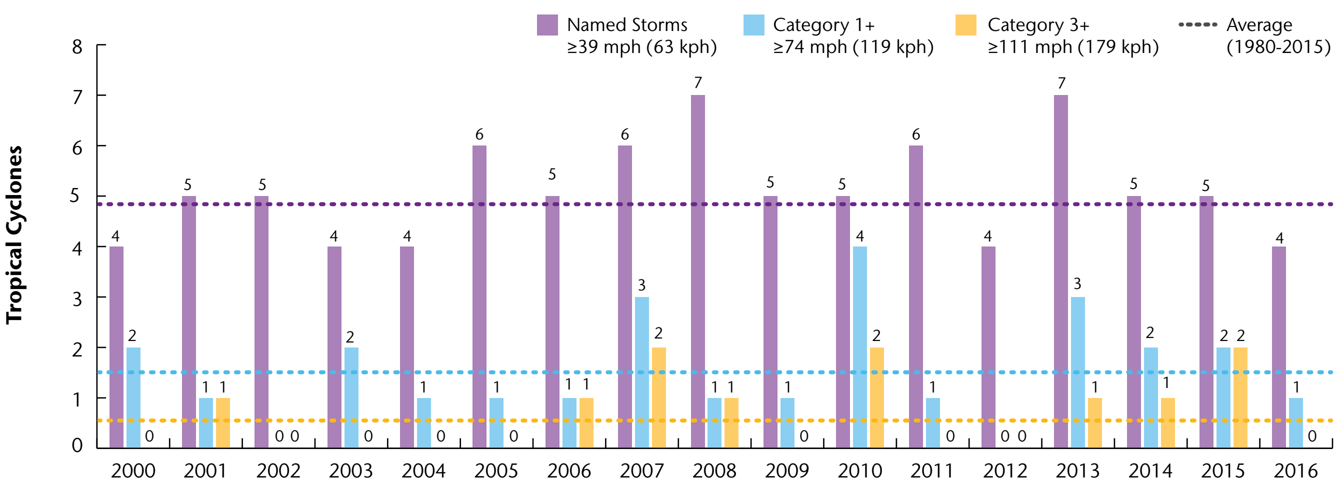
The season was highlighted by May's Cyclonic Storm Roanu which prompted torrential rainfall and widespread flooding and landslides in Sri Lanka that claimed more than 200 lives. More than 5,000 homes were damaged or destroyed and economic losses in the country were estimated at up to USD1.7 billion. Insured losses were expected to cover about six percent of this total. Roanu also brought heavy rainfall to portions of the Indian states of Tamil Nadu, Andhra Pradesh, Odisha, and West Bengal before it made landfall near Chittagong, Bangladesh as a tropical storm strength system. At least two dozen people were killed in Bangladesh.

Three more named storms formed during the season: Cyclonic Storm Kyant in October, Cyclonic Storm Nada in November-December, and December's Cyclonic Storm Vardah. Both Kyant and Nada reached tropical storm strength along with an un-named system that formed in the Arabian Sea in late June. Kyant remained over the open waters of the Bay of Bengal throughout its lifetime; while Nada brought heavy rainfall to portions of Sri Lanka and Tamil Nadu state, India. The unnamed Arabian Sea cyclonic storm triggered heavy downpours for southern parts of Oman. No casualties or major damage were reported as a result of any of these storms.

Vardah was the only storm to reach cyclone strength this year as it peaked at Category 1 intensity during December. Vardah made landfall near Chennai, Tamil Nadu, at this intensity and caused significant disruption throughout the city. At least a dozen people were killed.

The North Indian Ocean Cyclone Season officially runs throughout the calendar year, though most activity occurs between the months of April and December. For additional North Indian Ocean Basin landfalling tropical cyclone data, please see Appendix D.

Exhibit 27: North Indian Basin Tropical Cyclone Activity



Southern Hemisphere Cyclone Season Review

The Southern Hemisphere saw below average tropical cyclone activity in 2015-2016. A total of 21 named storms developed in the region, which is 20 percent below the average of 26 since 1980. Ten cyclones (Category 1+) formed which was also below the 1980-2015 average of 14. Additionally, just five cyclones reached Category 3+ strength, which is approximately 21 percent below the 36-year average of seven: two reached Category 5 strength. Out of the 10 Category 1+ cyclones, just two made landfall: one of which came ashore at Category 3+ strength or higher. The number of Category 1+ cyclones to make landfall was just below the 1980-2015 average of three while the one cyclone to make landfall at Category 3+ strength was equal to the long-term average.

The most significant cyclonic activity in the Southern Hemisphere occurred in Fiji where Cyclone Winston wrought havoc in February. Winston made landfall on the Fijian island of Viti Levu as a Category-5 strength system with wind speeds of 285 kph (180 mph): the strongest storm to make landfall in Fiji in recorded history. However, the storm reached its maximum intensity just prior to landfall with wind speeds of 295 kph (185 mph) making it the most intense tropical cyclone to form in the Southern Hemisphere since reliable records began in 1970. Winston inflicted severe and extensive damage across the Fijian archipelago, claiming 44 lives and damaging/destroying 40,000 homes.

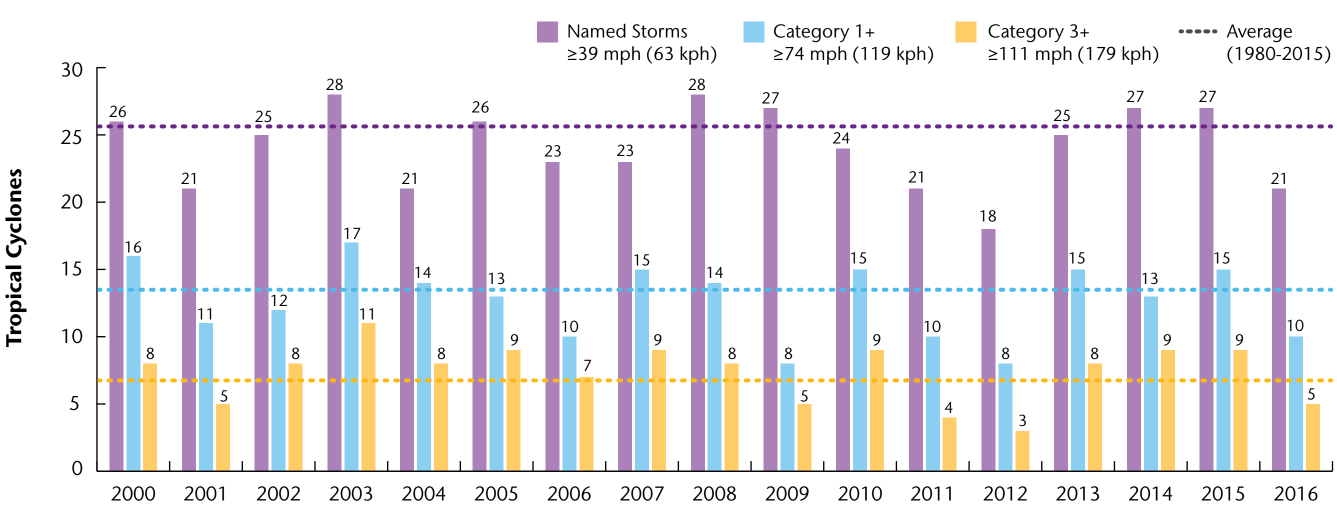
The USD1.4 billion economic cost equaled more than one-third of Fiji's GDP. Cyclone Winston also caused significant damage throughout the northern Tongan Islands while the remnants of the system brought stormy weather conditions to northeastern portions of Australia.

Other notable cyclones to form in the Southern Hemisphere included April's Cyclones Zena and Fantala. Zena brought torrential rainfall to portions of Fiji that were already enduring a significant flooding event. The additional precipitation from Cyclone Zena added to the severity of the flooding that was already impacting areas previously affected by Cyclone Winston. Cyclone Fantala equalled the record of the most intense cyclone on record in the Southwest Indian Ocean when its peak wind speeds reached 280 kph (175 mph) tying with 1995's Cyclone Agnielle.

Australia experienced its least active tropical cyclone season since records began in 1969 with just one named storm making landfall in the country. January's Cyclone Stan made landfall in a largely unpopulated region of northern Western Australia as a tropical-storm strength system.

The Southern Hemisphere Cyclone Season officially runs from July 1 to June 30. (The 2016 season ran from July 1, 2015 to June 30, 2016.) For additional Southern Hemisphere landfalling tropical cyclone data, please see Appendix D.

Exhibit 28: Southern Hemisphere Tropical Cyclone Activity



United States Tornado Season Review

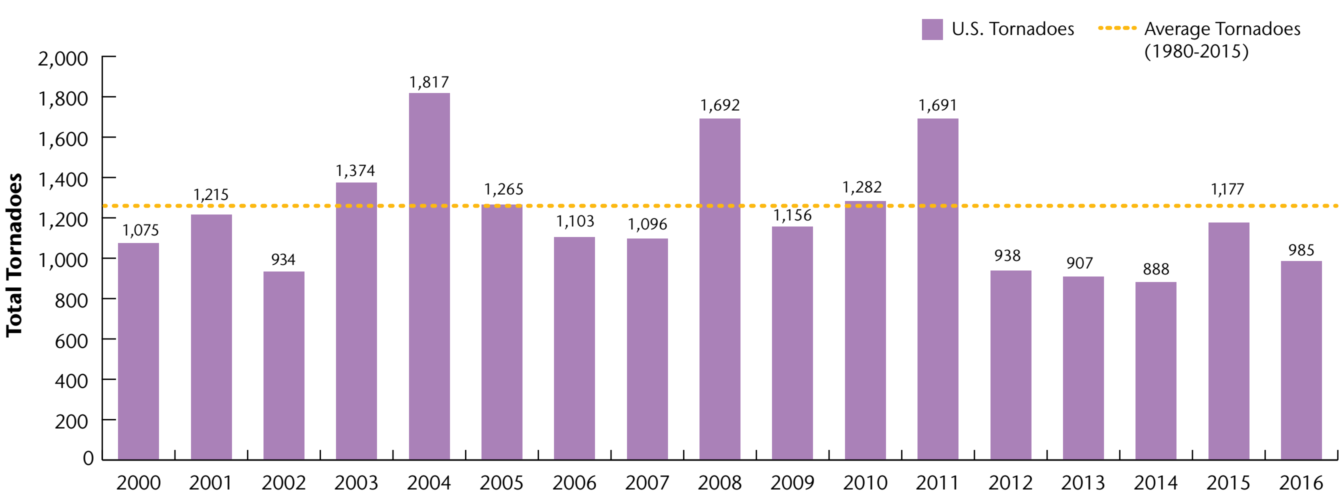
Tornado activity was slightly down across the United States in 2016 after an uptick in 2015. A preliminary count from the Storm Prediction Center (SPC) tallied 985 tornadoes, which was 16 percent lower than the 1,177 twisters in 2015 and 11 percent higher than the 888 in 2014. The count in 2016 was 19 percent below the Doppler radar-era (1990-2015) average of 1,221, and marked the fourth year since 2011 that there have been fewer than 1,000 touch downs. The busiest day for tornadoes in 2016 was February 23, when 52 touched down. The use of Doppler radar, beginning in the early 1990s, has led to markedly improved tornado detection. Because of this improved detection, the observed annual average number of tornadoes has risen, particularly with weaker tornadoes (EF0). There were 28 tornadoes rated EF3 or greater in 2016, with no EF5 tornadoes touching down for the third consecutive year. This compares to the 21 EF3 or greater tornadoes that impacted the US in 2015.

A total of 8 killer tornadoes (tornadoes that caused fatalities) occurred across the United States. This was the fewest number of annual killer tornadoes in the U.S. since official data records began being kept in 1950. The killer tornadoes left 17 people dead, which was 75 percent below the 36-year average of 68. This marked the fewest number of tornado-related fatalities in the U.S. since 1986 (15). Tornado-related fatalities tallied 36 in 2015. The vast majority of the casualties occurred during the first half of the year as 14 were recorded by the end of May. February was the deadliest month (7).

The deadliest twisters of the year occurred on February 24 and November 9, when three people were each killed. The February event touched down in Sussex County, Virginia; while the November event impacted Jackson County, Alabama. The 2016 fatality by state breakdown includes: Virginia (4), Alabama (3), Florida (2), Oklahoma (2), Louisiana (2), Tennessee (2), Mississippi (1), and Texas (1).

For additional United States tornado data, including a look at a breakdown of tornado frequencies by month and during ENSO cycles, please see Appendix E.

Exhibit 29: United States Tornado Activity



United States Wildfire Season Review

Following a record year for wildfire activity in the United States, the overall acreage area burned in 2016 was much reduced though still higher than the 1983-2015 average. The National Interagency Fire Center (NIFC) reported that an estimated 65,575 wildfires burned 5,446,520 acres (2,204,130 hectares) of land. More than 90 percent of the acres burned occurred in the Lower 48 states. The fires of 2016 were substantially less than the 68,151 fires in 2015 that charred a record 10,125,149 acres (4,097,506 hectares), but higher than the 33-year average of 71,640 fires burning 4,830,796 acres (1,954,955 hectares). The average acres burned per fire during the year was 83.06 acres (33.61 hectares), which was 22 percent higher than the normal 68.04 acres (27.54 hectares). However, it was 46 percent lower than the record 148.57 acres (60.12 hectares) set in 2015.

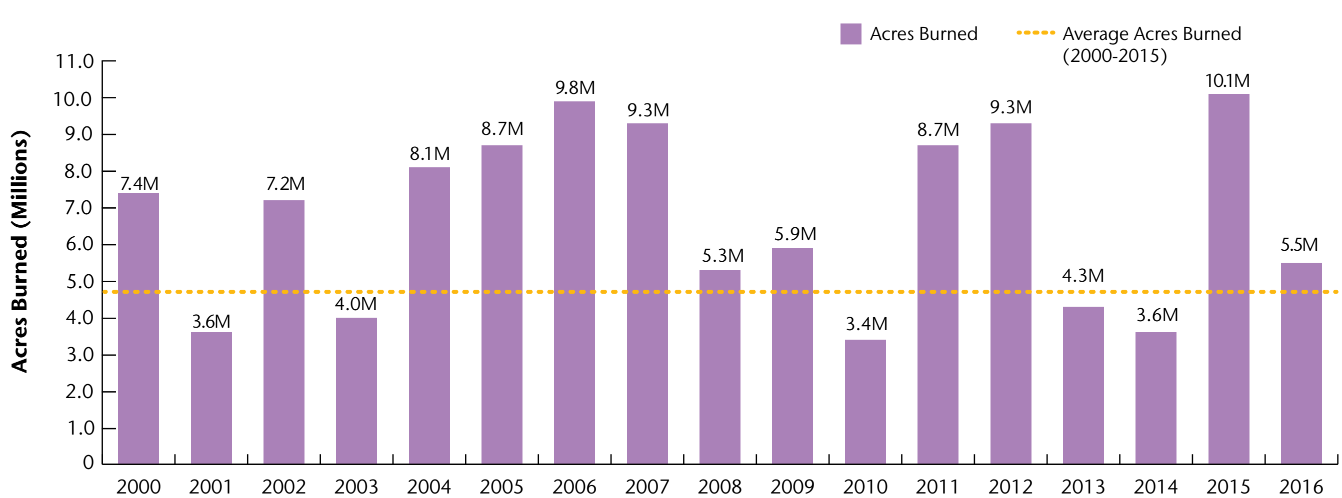
The most devastating wildfire activity occurred in the state of Tennessee during the end of November after the Chimney Tops 2 Fire – and many others – caused catastrophic structural damage and fatalities in Sevier County. In total, a minimum of 2,461 homes, businesses and other structures were damaged or destroyed in the county. Fourteen people were killed. Most of the damage occurred in the towns of Gatlinburg and Pigeon Forge. The economic cost was anticipated to approach USD900 million and become one of the costliest non-California wildfire events in US history.

Other major wildfire activity in the United States was registered in California. Among the notable fires that burned in the state during the summer and fall months included the Erskine Fire, Sand Fire, Bluecut Fire, Clayton Fire and the Soberanes Fire. Additional summer fires left considerable damage to forestry and structures in parts of Washington, Idaho and Oregon.

The remnant impacts from the 2015/16 El Niño, in addition to the transition to a weak La Niña, likely played a role in the intensity of wildfires throughout the U.S. and around the world. Many regions of the globe – including much of Southeast Asia and southern Africa – continued to deal with some of the worst drought conditions in decades. This enhanced the regional wildfire risk. A series of November wildfires, combined with the work of arsonists and windy conditions, also led to extensive fire damage in Israel. More than 1,700 structures were destroyed, with a total economic cost listed at USD520 million.

For additional United States wildfire data, please see Appendix F.

Exhibit 30: United States Wildfire Activity



European Windstorm Season Review

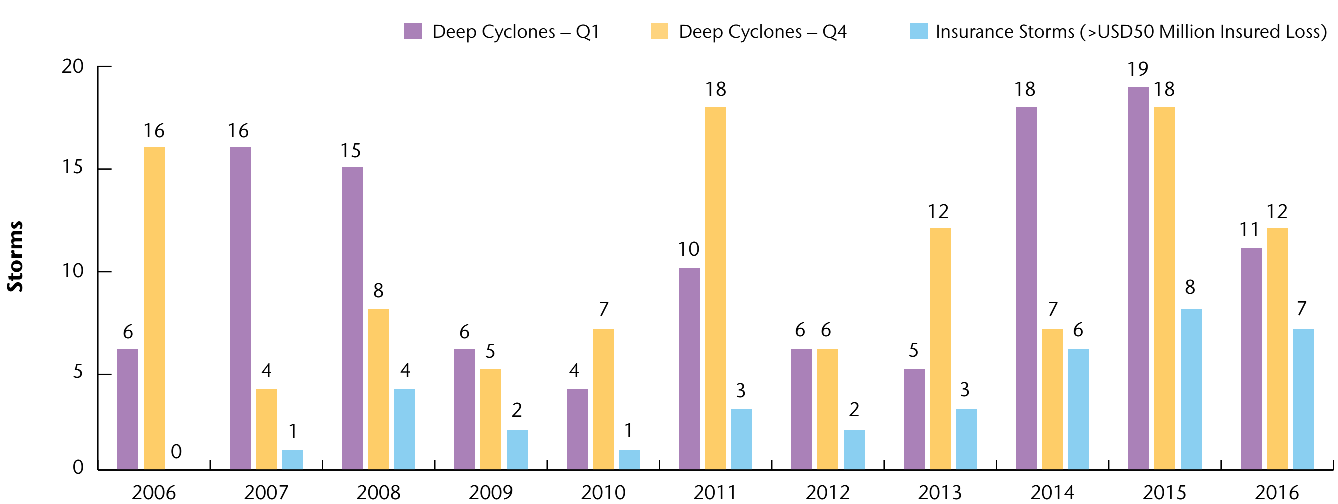
Although not exceptional in terms of total financial loss, the 2015/16 windstorm season was remarkable due to the high number of damaging storms that hit several European countries. In total, 10 storms caused more than USD50 million in insured losses during the period from October 2015 to March 2016. The second half of the season, spanning from January to March 2016, was marked by five damaging storms, four of which incurred more than USD100 million in insured losses: Marita (known as Gertrude in the UK and Ireland), Ruzica (Imogen), Aloisia (Jake) and Jeanne (Katie). The first significant storm of the ongoing season 2016/17 was Nannette (Angus). Tracking over the English Channel in November, the storm generated strong winds in coastal areas of continental Western Europe and prompted flooding in southern parts of the UK.

It is still too early to assess the whole 2016/17 windstorm season. However, the period from October to December 2016 was relatively quiet due to subdued meteorological conditions prevailing over the European continent. During much of late November and December, a high-pressure blocking pattern persisted over the western half of Europe, which prevented most extratropical cyclones from moving directly towards the continent. Instead, they were diverted towards Iceland, the Norwegian Sea or further north – this also had a negative effect on the Arctic sea ice growth. The blocking pattern also produced several cold spells for much of Eastern and Central Europe and portions of the Middle East.

For the purpose of this analysis, all North Atlantic extratropical cyclones named by Free University of Berlin, with core pressure minimum lower than 970 hPa and occurring in period from October to March, were taken into account and listed as 'deep cyclones'. In terms of calendar year comparison, 2016 saw 23 storms develop, which was slightly above the 10-year average of deep extratropical cyclone occurrence of 21.

Data for the last 10 years also shows a significant annual variability in terms of both number of events and insured losses. The last three years were marked by a higher number of storms that incurred significant damage. However, total insured loss has been decreasing since 2007 and remained 71 percent below the 10-year average in 2016. Total losses caused by any particular windstorm are influenced by several factors besides core pressure, including its track, maximum wind speeds or extent of affected area. Windstorm Kyrill in 2007 remains the most damaging event of this century in terms of insured loss, despite the fact it was the only significant storm to strike that year.

Exhibit 31: North Atlantic Cyclonic Activity



Global Earthquake Review

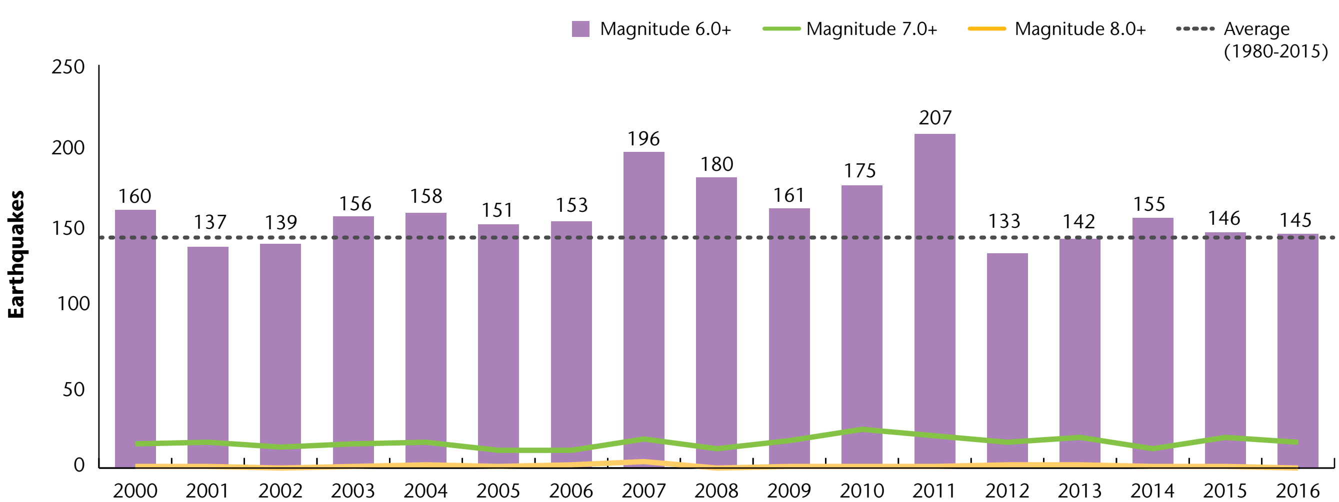
The number of recorded global earthquakes (≥M6.0) was near average in 2016. Based on data from the United States Geological Survey's (USGS) National Earthquake Information Center (NEIC) and the Advanced National Seismic System (ANSS), there were 145 earthquakes with magnitudes greater than 6.0, 17 earthquakes with magnitudes greater than 7.0 and no earthquakes with a magnitude greater than 8.0. This compares to the 146 (≥M6.0), 19 (≥M7.0) and 1 (≥M8.0) seen in 2015, and the 1980-2015 averages of 142 (≥M6.0), 14 (≥M7.0) and 1 (≥M8.0). The highest number of M6.0 or greater earthquakes was 207, set in 2011.

Despite the slightly fewer number of large earthquake events, there were multiple events that were extremely costly. The costliest event of the year for the peril was the series of earthquakes in Japan's Kumamoto prefecture in April 2016. The M7.0 and M6.2 tremors left catastrophic damage throughout the region, with more than 250,000 insurance claims filed resulting from impacted homes, businesses and vehicles. Total economic losses tallied roughly USD38 billion.

A magnitude-7.9 earthquake that struck just to the east of Papua New Guinea on December 17 was the year's largest; while four magnitude-7.8 earthquakes were also recorded. The most noteworthy of these tremors was the November 14 (local time) tremor in New Zealand. The temblor's epicenter struck on the north end of the South Island near Kaikoura, though damage was recorded in both the North and South islands. Another magnitude-7.8 earthquake led to widespread destruction in Ecuador on April 16. That event left at least 673 people dead and caused USD3.4 billion in economic damage. Other significant earthquakes impacted central Italy during August (M6.2) and October (M6.6, M6.1, M5.5) that combined to cause more than USD5.0 billion in economic damage.

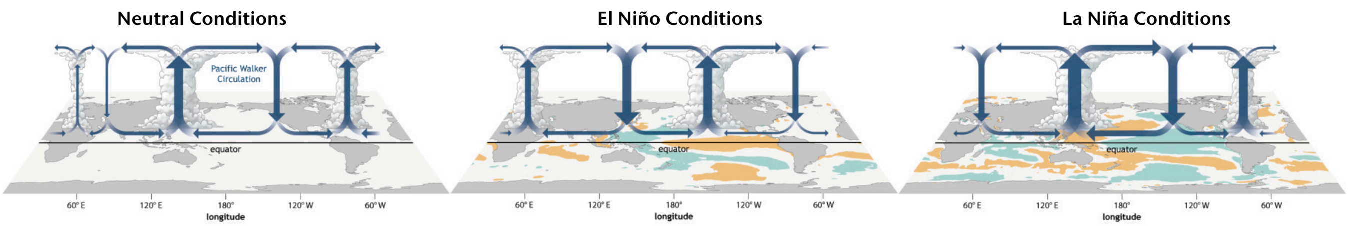
As shown in Exhibit 31, overall earthquake activity does not tend to show large fluctuations on an annual basis. The USGS cites that a substantial increase in seismograph stations and continued improvements in global technology and communication has greatly strengthened the quality of earthquake data collection. It should also be noted that despite fluctuations in the number of total earthquakes since the early 1900s, the number of recorded major earthquakes (≥M7.0) have remained fairly consistent on a year-to-year basis.

Exhibit 32: Global Earthquake Activity ≥M6.0



El Niño/Southern Oscillation (ENSO) Background

Exhibit 33: Phases of the El Niño/Southern Oscillation (ENSO)



Source: NOAA

There are several atmospheric and oceanic dynamics that impact tropical cyclone development across the globe. One of the main driving climate factors for the globe's weather activity is the El Niño/Southern Oscillation (ENSO), which is an anomalous warming or cooling of the central Pacific Ocean waters that generally occurs every three to seven years, mainly between August and February.

During neutral conditions, surface trade winds blow from the east and force cooler waters that are upwelled from the deeper depths of the Pacific Ocean to the surface across the western coast of South America. Because of the displacement of water flowing to the west, the ocean is up to 60 centimeters (two feet) higher in the western Pacific Ocean as it is in the eastern Pacific Ocean. The warmer waters are forced into the western portions of the ocean, allowing thunderstorm activity to occur across the western half of the Pacific Ocean.

During El Niño conditions, the surface trade winds that normally blow from east to west weaken and sometimes even reverse direction. This allows the warmer waters to remain or even traverse eastward, bringing more frequent thunderstorm activity to the central and eastern portions of the Pacific Ocean. Warm and very wet conditions typically occur across Peru, Ecuador, Brazil and Argentina from December through April. Portions of Central America, Colombia and the Amazon River Basin are dry, as are southeastern Asia and most of Australia. In Africa, El Niño's effects range from wetter-than-average conditions across eastern portions to warmer and drier-than-average conditions across southern portions. In North America, the polar jet stream (the jet stream that is responsible for Arctic outbreaks) is usually pushed northward, keeping cold Arctic air across the northern portions of Canada. Warmer-than-average temperatures typically occur across the northern United States and southern Canada. The subtropical jet stream, which usually sinks southward during the winter months, will drift northward and bring a succession of storm systems across the southern tier of the U.S. and northern Mexico.

During La Niña conditions, the surface trade winds will strengthen, promoting additional cooler water to be upwelled from the depths of the Pacific Ocean up to the surface and forced westward. This forces thunderstorm activity across the Pacific Ocean westward and often brings fewer tropical systems to the central and eastern Pacific regions. Because of the waters' influence on the upper atmospheric jet stream, La Niña's effects, like El Niño's effects, are experienced worldwide. The main effects are usually noted across the western Pacific regions, where wetter conditions are expected, especially during the beginning months of the year. Wet and cool conditions are typical across southern Africa and eastern South America between December and February. With the polar jet stream displaced further south, cool and wet conditions occur across the northern half of the North America West Coast, while dry and mild conditions are experienced for the southern half of the United States into northern Mexico. If La Niña's cycle continues into June, July and August, warm and wet conditions often occur across Indonesia and the southern half of Asia, while cool and wet conditions are found across the southern portions of the Caribbean Ocean.

See Appendix C for ENSO's effects on tropical system frequency for all of the global basins.

Atlantic Hurricane Season Forecast Review

Historical Prediction Verification

Abundant media coverage is given to various organizations across the world that issue hurricane season predictions for the Atlantic Ocean Basin. These organizations utilize meteorological and climatic data obtained, in some instances, up to six months in advance to determine how active or inactive the Atlantic Hurricane Season will be in the upcoming year. Several different professional entities issue these forecasts, ranging from governmental agencies to universities to private companies. Three organizations which consistently make their forecasts available to the public are:

- Colorado State University (CSU), a forecast group sponsored by Colorado State University and private companies that is led by Dr. Philip Klotzbach
- The National Oceanic and Atmospheric Administration (NOAA), the United States' official governmental climatological and meteorological office
- Tropical Storm Risk (TSR), an Aon Benfield-sponsored forecast group based in London, England led by Professor Mark Saunders and Dr. Adam Lea

Some of these entities disclose in detail the parameters being used to derive these forecasts, while others cite general factors for the reasoning of their predictions. CSU and TSR provide specific numbers for each year's forecasts, while NOAA provides a range of values.

The forecasts for the last five years were made in May or June, and along with the actual total number of named storms, hurricanes and major hurricanes, this data is shown in the following tables. The May/June forecast was chosen to show the level of skill for each agency prior to the official start of hurricane season. Additionally, a five-year cumulative forecast is shown to emphasize that long-term forecasting may yield more information on general frequency shifts than short-term forecasting.

Exhibit 34: 2016 Forecasts

	May/June Atlantic Hurricane Season Forecast				
Forecast Parameter	1980-2016 Average	CSU	NOAA	TSR	2016 Season Total
Named Storms	13	14	10-16	17	15
Hurricanes	7	6	4-8	9	7
Major Hurricanes	3	2	1-4	4	3

Exhibit 35: Five-Year Average Forecasts

	May/June Atlantic Hurricane Season Forecast				
Forecast Parameter	1980-2016 Average	CSU	NOAA	TSR	5-Year Season Avg.
Named Storms	13	13	10-15	14	13
Hurricanes	7	5	4-8	6	6
Major Hurricanes	3	2	2-4	3	2

United States

Exhibit 36: Top 5 Most Significant Events in the United States

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
August	Flooding	Louisiana	13	10 to 15 billion	3.0 billion
October 5 – 10	Hurricane Matthew	Southeast, Mid-Atlantic	49	10 billion	4.0 billion
April 10 – 15	Severe Weather	Texas, Southeast	1	4.3 billion	3.2 billion
April 15 – 19	Flooding	Texas, Plains, Rockies	9	2.0 billion	1.0 billion
November	Wildfire	Tennessee	14	900 million	650 million
		All Other Events	~169	35 billion	19 billion
		Totals	**~255**	**58 billion[1]**	**30 billion[1,2]**

Economic and insured losses derived from natural catastrophes in the United States were the costliest in the country since 2012 at USD58 billion and USD30 billion, respectively. On an average basis, economic losses tied with the 2000-2015 mean and insured losses were five percent lower. This is primarily due to outlier years in 2005 and 2012 skewing the loss data. When using a median analysis, the 2016 losses were actually 62 percent higher (economic) and 39 percent higher (insured). It is worth noting that this is the first time since 2012 that the U.S. had multiple catastrophes with economic losses in excess of USD10 billion.

The most highly publicized event in the U.S. was Hurricane Matthew; the second hurricane to make landfall in the U.S. in 2016 (following Hermine in Florida). Despite making landfall as a minimal Category 1 storm, it grazed the coastlines of Florida, Georgia and the Carolinas while bringing significant storm surge, coastal flooding and hurricane-force winds. Excessive rains prompted major riverine flooding in North Carolina. Total economic losses were estimated at up to USD10 billion; while public and private insurers expected losses to approach or exceed USD4.0 billion.

Another catastrophic event occurred during the month of August in the state of Louisiana following historic rainfall. Isolated areas around the city of Baton Rouge recorded 1-in-1,000 year rainfall totals that led to extensive riverine and flash flooding. At least 188,000 homes and structures were inundated as overall economic losses were estimated to range between USD10 and 15 billion. Given low take-up rates of the National Flood Insurance Program (NFIP), a high percentage of the losses were uninsured, with the total estimated insured loss minimally expected to be USD3.0 billion.

Other major US events included a series of substantial hailstorms that swept across the state of Texas throughout the year. The state incurred record thunderstorm-related losses as insurers cited costs exceeding USD8.0 billion. One particular April stretch of hail impacted the greater Dallas and San Antonio metro regions that cost insurers at least USD3.0 billion. The state also recorded a major April flash flood event near the city of Houston that had a billion-dollar financial toll.

Tennessee endured one of the costliest non-California wildfire events in US history during November. More than 2,460 structures were damaged as the insured loss alone neared USD650 million.

For a detailed review of all events in 2016, please visit **www.aonbenfield.com/catastropheinsight** and click on "Thought Leadership" to download updated monthly Global Catastrophe Recaps.

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

Real-Time Flood Response

Dan Dick
Global Head of Catastrophe Management at Aon Benfield

The Louisiana floods of August 2016 highlighted the need for re/insurers to understand the impact of the hazard in real-time. Within days of the event reaching its peak, Impact Forecasting provided flood extent maps as part of its Cat Event Response. These outlined both the breadth of the impacted area and peak flow locations, based on satellite imagery, hydrologic and hydrodynamic modeling, and GIS expertise.

Additionally, Impact Forecasting released an event representing the Louisiana floods in its ELEMENTS platform. This enabled re/insurers to produce loss estimations based on the type and value of exposures, plus inundation depth at the various locations. This analysis helped re/insurers further enhance their view on the severity of the floods, by both understanding their exposures and accessing credible loss estimations.

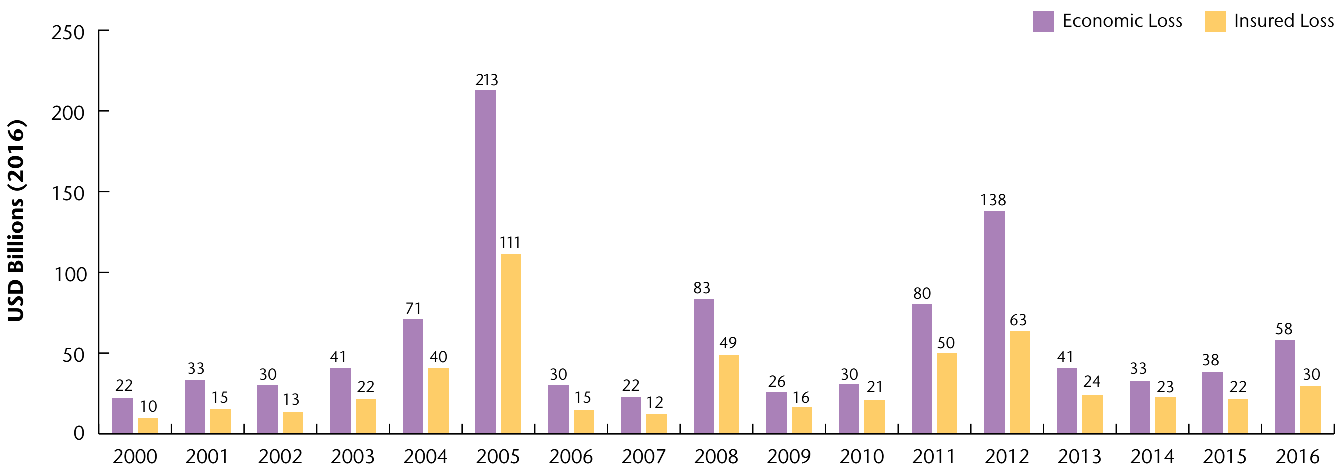
Many US insurers further analyzed the footprints in the ImpactOnDemand risk mapping tool. As the maps were constantly refined into more complex shapes, the tool enabled insurers to overlay their exposures on the flood extent maps and, with a high degree of precision, evaluate whether or not their insured properties were within the impacted areas.

Feedback from clients utilizing these maps was overwhelmingly positive: they were able to identify impacted insureds, quantify exposed insured values, provide risk counts and accumulation reports to their claims teams, and quickly illustrate to management the vast area of the state impacted and their exposure to this flood.

The technical expertise required to create these precise and complex maps was complemented by regular Cat Alerts from the Impact Forecasting team. These updates provided further detail on the historical content and on-ground observations of the damage to keep re/insurers better informed during a major event.

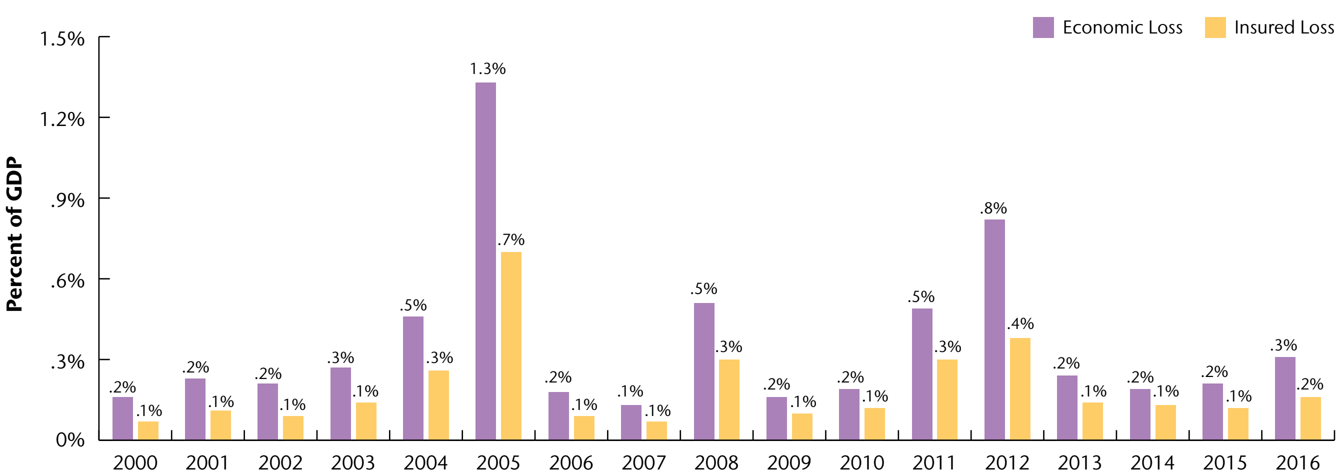
Within days of the event reaching its peak, Impact Forecasting provided flood extent maps for Louisiana. This enabled re/insurers to quantify exposed insured values for management and provide accumulation reports to their claims teams.

Exhibit 37: United States Economic and Insured Losses



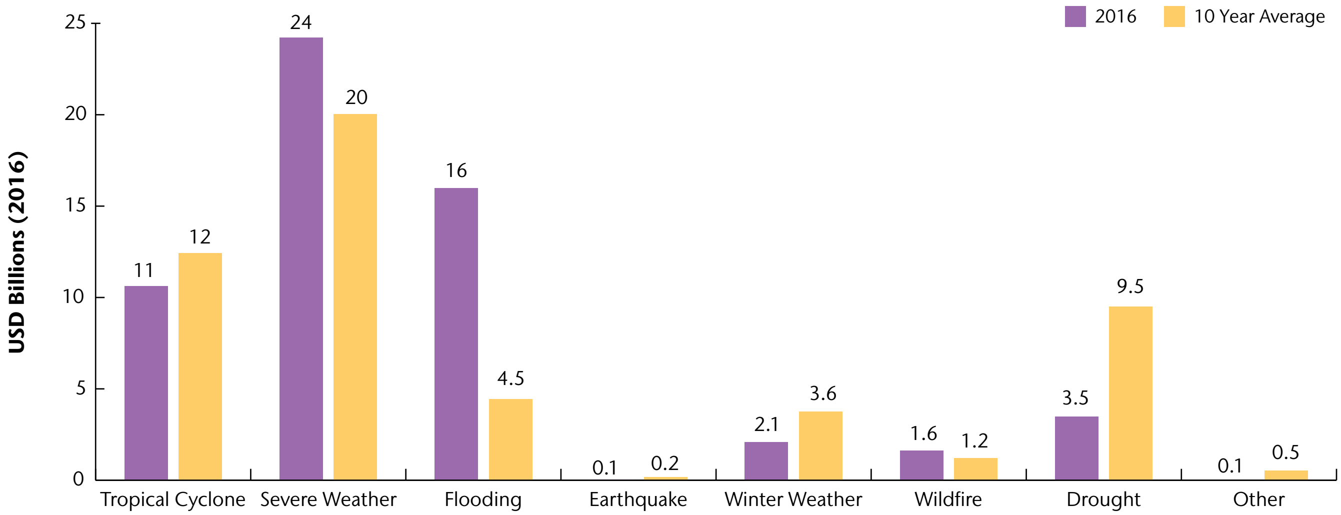
Both economic and insured losses on an inflation-adjusted basis have averaged positive annual growth since 1980. Economic losses have shown an annual average growth rate of 3.2 percent; while insured losses have increased at a slightly faster 6.2 percent. When analyzing the same data back to 2000, the rate of growth has slowed slightly to 2.2 percent (economic) and 3.9 percent (insured). As coastal exposures and properties in more vulnerable locations grow, this is expected to lead to continued positive loss trends in the future.

Exhibit 38: United States Economic & Insured Losses as Percentage of GDP



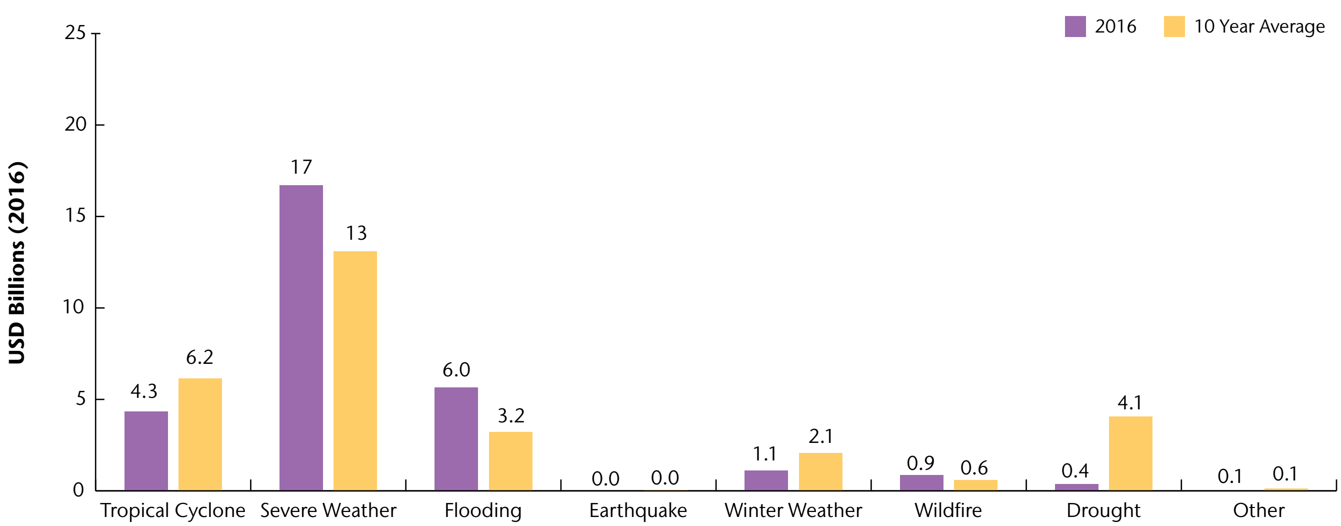
When analyzing natural disaster losses as a percentage of US GDP (World Bank), the rate of growth since 1980 has increased annually by 1.0 percent for economic losses and 3.8 percent for insured losses. However, the last 16 years of data indicates that the rate of growth has slowed slightly to 0.7 percent (economic) and 2.4 percent (insured).

Exhibit 39: United States Economic Losses by Peril



The severe weather, flooding and tropical cyclone perils dominated economic losses in the United States in 2016. The severe weather, flooding and wildfire perils were the only ones above their individual 10-year averages. Events in Texas, Louisiana and Tennessee led the way for those peril types. It is worth noting that the severe weather peril has now overtaken tropical cyclone as the predominant driver of damage costs in the US since 2006.

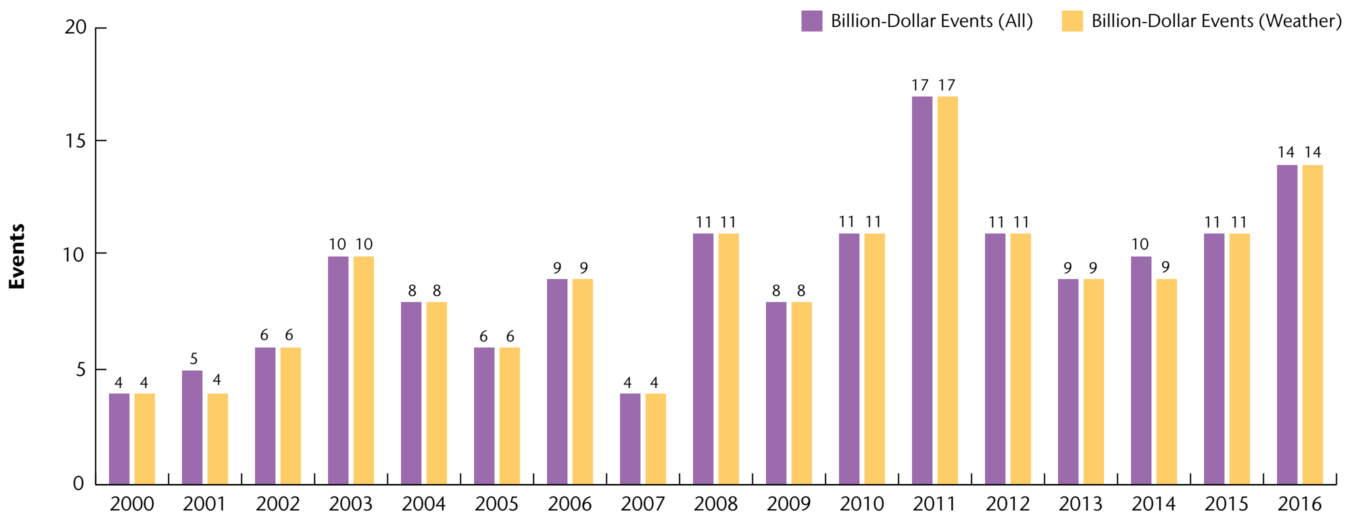
Exhibit 40: United States Insured Losses by Peril



Losses resulting from severe weather again accounted for the bulk of costs for the insurance industry. The roughly USD17 billion in claims payouts was nearly triple the next closest peril (flooding), and was the second-costliest year for insurers and the peril on record. The severe weather, flooding and wildfire perils were the only ones above their 10-year averages.

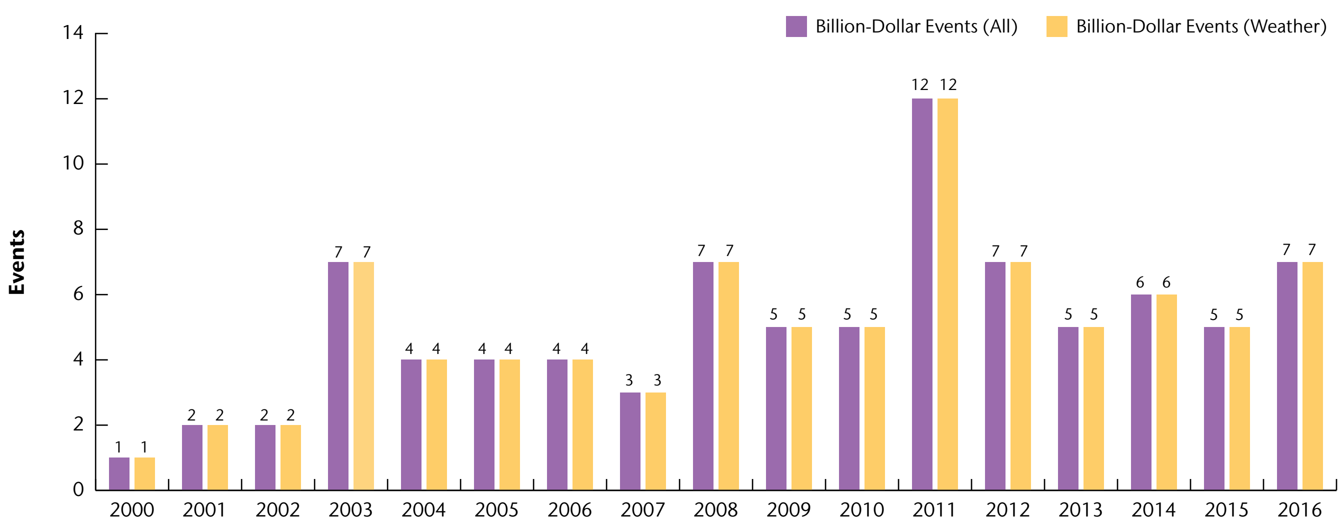
Please note that insured losses include those sustained by private insurers and government-sponsored programs such as the National Flood Insurance Program and the Federal Crop Insurance Corporation (run by the USDA's Risk Management Agency).

Exhibit 41: United States Billion-Dollar Economic Loss Events



There were at least 14 events that caused at least USD1.0 billion in economic losses in 2016, which was above the 16-year average (9). This is the second-most number of events ever recorded in the United States. All of the events were weather-related as the country went another year without experiencing a major earthquake. The breakdown of billion-dollar events by peril included severe weather (9), flooding (2), winter weather (1), and tropical cyclone (1).

Exhibit 42: United States Billion-Dollar Insured Loss Events



There were seven events that spawned insured losses beyond USD1.0 billion, which was above the 2000-2015 average of five. All of the events were weather-related. The breakdown of billion-dollar events included severe weather (4), flooding (2) and tropical cyclone (1).

Americas (Non-U.S.)

Exhibit 43: Top 5 Most Significant Events in the Americas (Non-U.S.)

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
Sept. 28 - Oct. 4	Hurricane Matthew	Caribbean	556	5.0 billion	1.0 billion
May 2 - 31	Wildfire	Canada	0	4.5 billion	2.8 billion
April 16	Earthquake	Ecuador	673	3.4 billion	551 million
April 4 - 10	Flooding	Argentina, Uruguay	0	1.3 billion	500 million
August 2 - 10	Hurricane Earl	Belize, Mexico, Caribbean	67	250 million	25 million
		All Other Events	~150	2.0 billion	917 million
		Totals	**~1,490**	**17 billion[1]**	**6.0 billion[1,2]**

Economic and insured losses derived from natural catastrophes in the Americas (Non-U.S.) were above the 2000-2015 norm and more than double the incurred losses (on both an economic and insured basis) in 2015. The region has only incurred economic losses beyond USD20 billion three times (2005, 2010, 2013) and insured losses beyond USD10 billion once (2010) and these records still stand despite higher than average losses in 2016. Economic losses in 2016 (USD17 billion) were 21 percent above the 2000-2015 average and, on a median basis, were an even more substantial 105 percent higher. Insured losses (USD6.0 billion) were 160 percent higher than the recent average, and an even greater 274 percent higher on a median basis.

The most significant event of 2016 in the region was the passage of Hurricane Matthew through the Caribbean during late September and early October. The storm made separate landfalls in Haiti and Cuba and prompted catastrophic damages for portions of the Bahamas, Cuba, Haiti, and the Dominican Republic. At least 600 people were killed – the majority of who were in Haiti, with unofficial totals up to 1,600 – and an estimated 200,000 homes were damaged or destroyed. Entire towns were virtually swept away. Economic losses in the Caribbean as a result of Matthew totaled more than USD5.0 billion. Earlier in the year, Hurricane Earl prompted damage in portions of the Caribbean, Belize, and Mexico. Almost 70 people were killed and 15,000 homes were damaged.

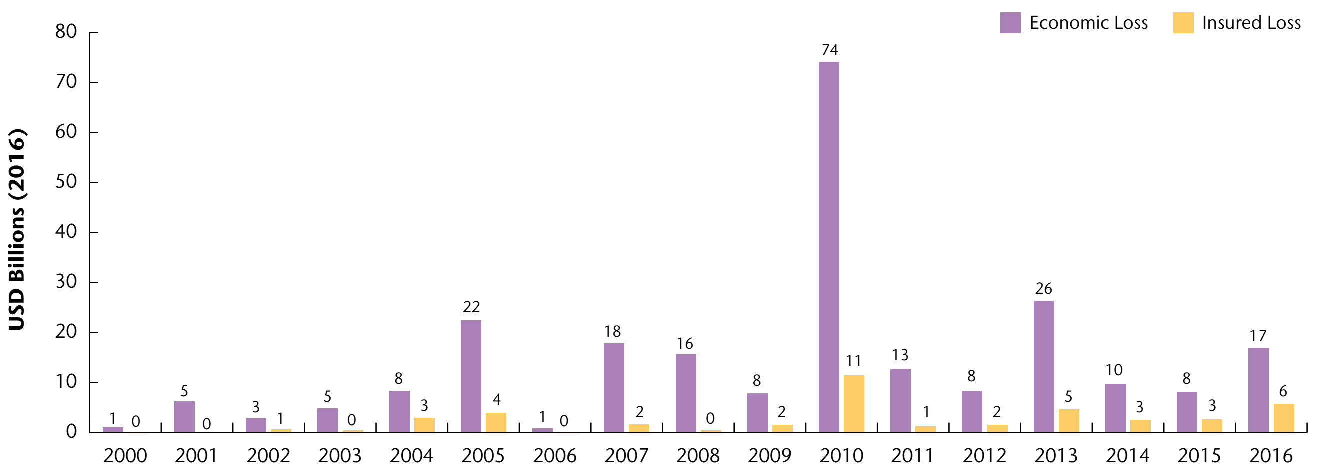
Canada's Fort McMurray was ravaged by the Horse Creek Wildfire during the month of May which prompted the largest evacuation in the history of the province of Alberta. More than 580,000 hectares (1.43 million acres) of land were charred and approximately 10 percent of Fort McMurray, including more than 2,400 homes and other structures, was destroyed. Insured losses of USD2.8 billion ensured the fire was the costliest natural disaster in Canadian history.

The most significant non-weather event was a magnitude-7.8 earthquake that struck Ecuador on April 16. The tremor tied with three other global events as the second strongest of 2016. At least 673 people were killed and more than 17,638 others were injured. The hardest-hit cities and towns were in Manabi state where more than 7,000 homes and businesses were damaged or destroyed. The economic cost for damage and reconstruction was reported at USD3.4 billion. Insured losses covered just 16 percent of this total.

For a detailed review of all events in 2016, please visit **www.aonbenfield.com/catastropheinsight** and click on "Thought Leadership" to download updated monthly Global Catastrophe Recaps.

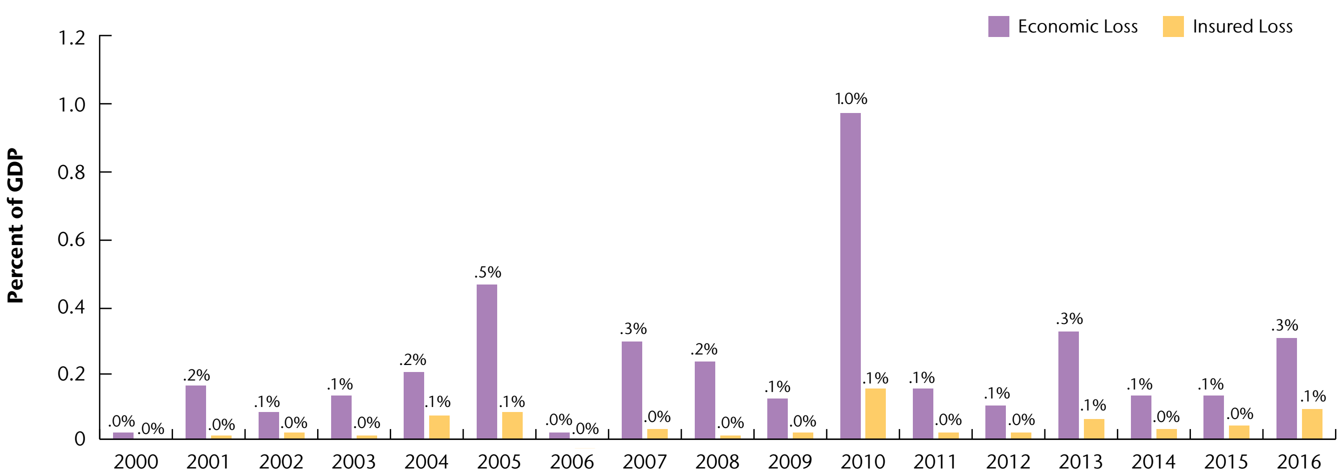
[1] Subject to change as loss estimates are further developed
[2] Includes losses sustained by private insurers and government-sponsored programs

Exhibit 44: Americas (Non-U.S.) Economic and Insured Losses



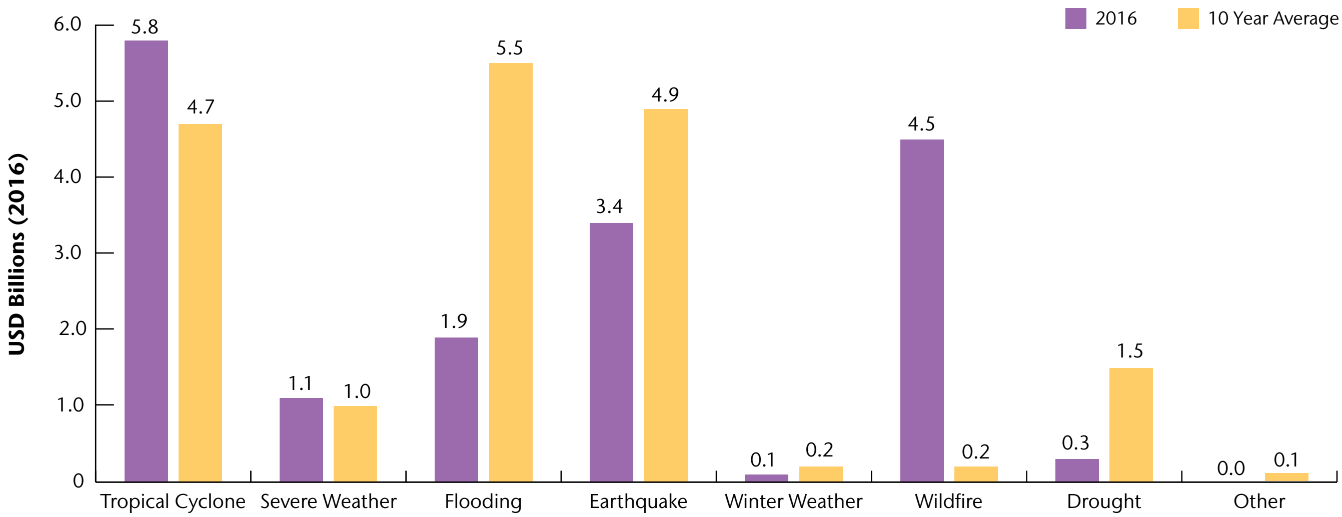
Since 1980, economic losses have increased about 4.3 percent and insured losses have increased at a more substantial 9.4 percent. Increases during the past 16 years accelerated (economic (12 percent); insured (23 percent)), though these totals are skewed by the 2010 Chile earthquake. These upward trending losses can be attributed to inflation, increasing population and risk exposure, higher levels of insurance penetration in developing markets in Latin America, and improved data availability. However, in spite of the growing trend of insured over overall economic losses, it is important to note that there remains a very low level of insurance penetration, particularly in Latin America.

Exhibit 45: Americas (Non-U.S.) Economic and Insured Losses as Percentage of GDP



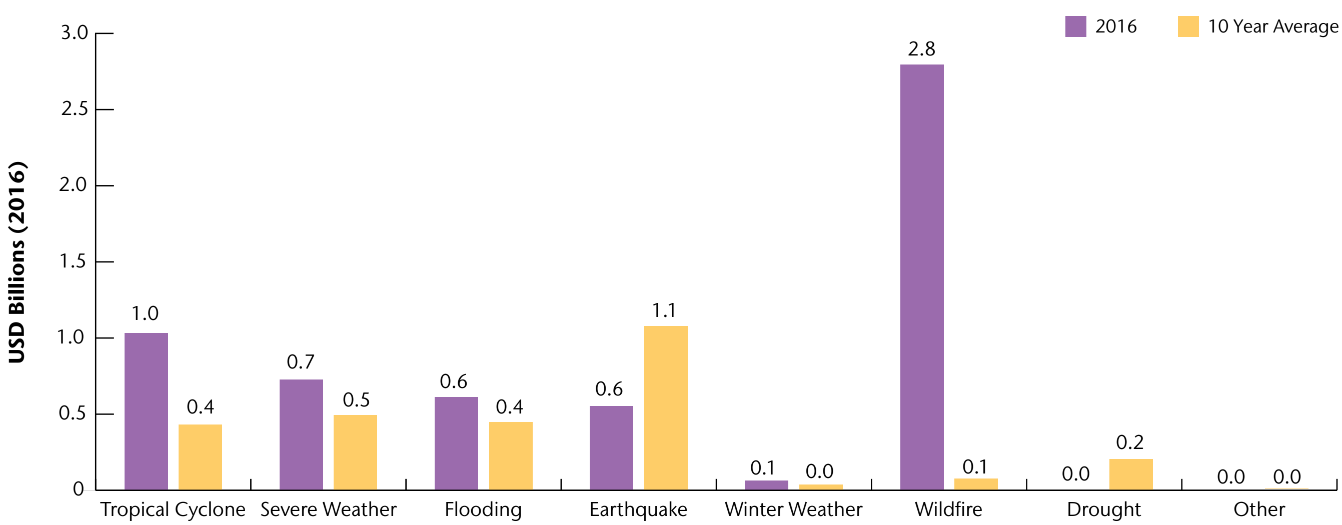
When analyzing natural disaster losses as a percentage of GDP (World Bank) for the Americas (Non-U.S.), the rate of growth since 1980 has remained generally flat annually (0.6 percent) for economic losses, but has increased 5.2 percent for insured losses. The recent 16-year trend averages are much more pronounced at 6.6 percent (economic) and 16 percent (insured). It is critically important to note that despite these trend increases since 2000, the percent of GDP on an economic and insured loss basis are less than one percent - and often less than 0.1 percent.

Exhibit 46: Americas (Non-U.S.) Economic Losses by Peril: 2016 vs 10 Year Avg



Three perils - wildfire, tropical cyclone, and severe weather - recorded economic losses above their recent 10-year averages in the region. Wildfire was a very substantial 2,250 percent above the long-term average with losses of USD4.5 billion during 2016. All other perils, including flooding and earthquake which accounted for the largest economic loss events in South America, were below normal. Tropical cyclone was the costliest peril in 2016 accounting for approximately one-third of all losses.

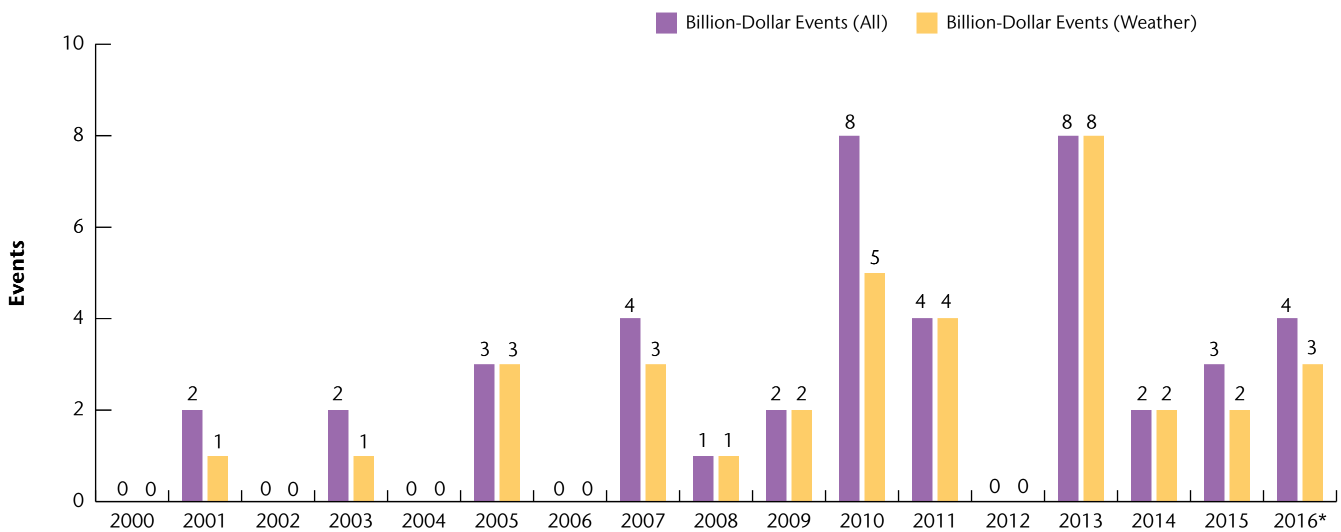
Exhibit 47: Americas (Non-U.S.) Insured Losses by Peril: 2016 vs 10 Year Avg



Insured losses were above the 10-year normal for multiple perils in 2015. Losses from earthquake, drought, flood and severe thunderstorm accounted for the highest percentage of payouts, though none of the perils saw aggregate losses in excess of USD1.0 billion. The longer-term averages further underscore the lack of insurance penetration in the Americas as only earthquake has averaged at least USD1.0 billion on an annual basis.

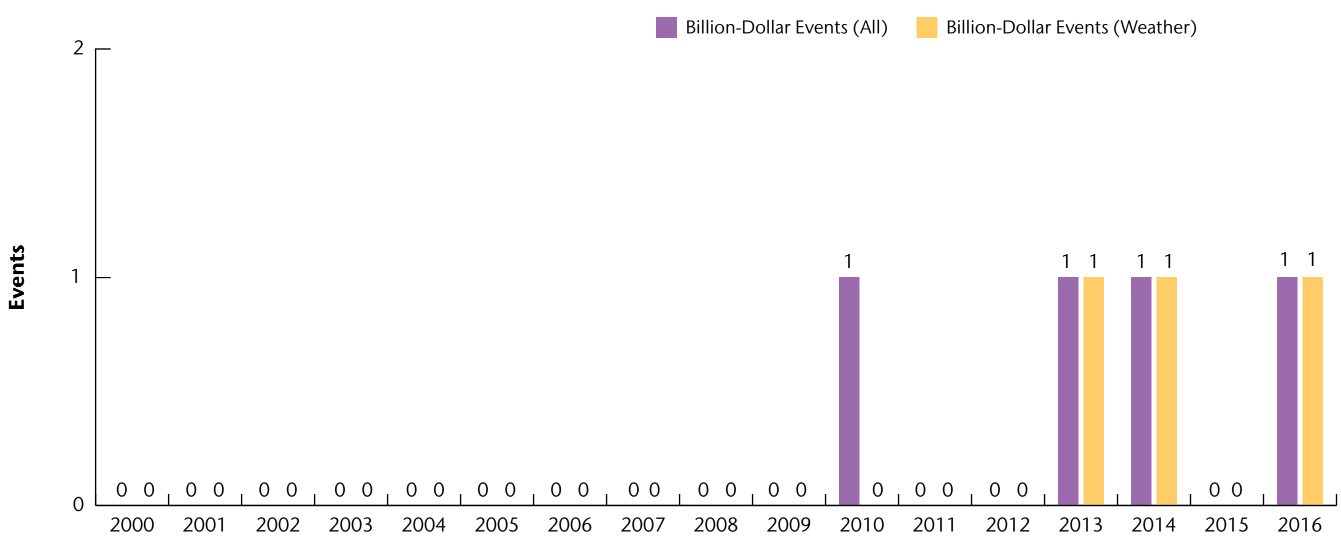
Please note that insured losses include those sustained by private insurers and government-sponsored programs

Exhibit 48: Americas (Non-U.S.) Billion-Dollar Economic Loss Events



There were four natural disaster events in the Americas (Non-U.S.) that caused at least USD1.0 billion in economic losses in 2016, which was equal to 2015 and double the 2000-2015 average of two. Three of the events were weather-related which was above the 2000-2015 average (two). The breakdown by natural disaster peril included wildfire (one), tropical cyclone (one), earthquake (one), and flooding (one). Please note that Hurricane Matthew caused more than USD1.0 billion in damage in both the United States and the Americas, but is only counted once in the overall global total.

Exhibit 49: Americas (Non-U.S.) Billion-Dollar Insured Loss Events



There was one natural disaster event in the Americas (Non-U.S.) that triggered insured losses at or beyond USD1.0 billion in 2016. This was well above the recent 10-year average of approximately one event every four years. The combination of lower levels of insurance penetration and lack of available data in Latin America contribute to the lower frequency of such events occurring or being reported. The only insured loss event to cross the billion-dollar insured threshold was the Horse Creek wildfire in Fort McMurray, Canada.

Hurricane Matthew caused more than USD1 billion in loss in the U.S. and Americas

EMEA (Europe, Middle East & Africa)

Exhibit 50: Top 5 Most Significant Events in EMEA

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
May - June	Flooding	Western & Central Europe	20	5.5 billion	3.4 billion
August 24	Earthquake	Italy	299	5.0 billion	73 million
January - June	Drought	Zimbabwe	N/A	1.6 billion	Unknown
June 23 - 24	Severe Weather	Netherlands	0	1.1 billion	560 million
March 8 - 11	Severe Weather	United Arab Emirates, Oman	0	500 million	150 million
		All Other Events	~820	5.2 billion	1.6 billion
		Totals	**~1,140**	**19 billion[1]**	**6.0 billion[1,2]**

Economic and insured losses derived from natural catastrophes in EMEA (Europe, Middle East, Africa) were both below the 2000-2015 norm. Total economic losses (USD19 billion) continued to increase moderately for the second consecutive year, but still remained 22 percent below the 2000-2015 average and 23 percent below the median of the same period. Insured losses (6.0 billion) were 19 percent below the 16-year average. On a median basis, 2016 was only two percent lower, as the average is slightly skewed by the above-average years 2007 and 2013, which were marked by significant floods and powerful windstorms. The costliest event of 2016 from both an economic and insured loss perspective was flooding that impacted Western & Central Europe in late spring.

Perhaps the most striking catastrophe that befell the European continent was a sequence of earthquakes in Central Italy. The August 24 tremor leveled several villages and killed almost 300 people. The shaking continued into the autumn months and culminated on October 30 with a 6.6-magnitude earthquake, the largest in Italy since 1980. The earthquakes combined to cause an economic loss of at least USD6.0 billion. The insured loss remained relatively low due to sparse market penetration.

Although there were not any historically significant European Windstorms in 2016, total insured losses attributed to this peril exceeded USD800 million. Six notable storms hit Europe in 2016, of which windstorms Marita, Ruzica and Jeanne were the most damaging. Please note that for consistency purposes, this report follows the naming convention established by Free University of Berlin.

The southern part of the African continent suffered from drought conditions in the first half of 2016 as a result of prevailing El Niño influence. The humanitarian situation in Zimbabwe, plagued by long-term economic crisis and persisting droughts, was particularly severe as millions of people were food-insecure. The government estimated the costs to be around USD1.6 billion. Tens of millions of people were also affected by the drought in Zambia, Malawi and South Africa.

The severe weather peril generated a billion-dollar event in the Netherlands. Powerful thunderstorms struck the central part of the country in late June, causing hail, wind and flood damage. Unusually severe thunderstorms also impacted United Arab Emirates and Oman in March, causing widespread damage.

For a detailed review of all events in 2016, please visit **www.aonbenfield.com/catastropheinsight** and click on "Thought Leadership" to download updated monthly Global Catastrophe Recaps.

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

Tackling Cross-Country Hazards

Dr. Martin Kadlec
Flood Model Developer at Impact Forecasting

Europe's largest insured loss of USD3.4 billion was caused by hail and wind but mostly flooding across France, Germany, Belgium, and Austria. Looking forward, this highlights the need to better quantify and manage the impact of flood on property and life through catastrophe modelling insights.

At the heart of this is extracting the loss and exposure data from these large flood events to help more accurately build catastrophe models. However, coupled with flooding from recent years (2002, 2005, 2010, or 2013), this has also raised another challenge: understanding how an international portfolio is impacted when several countries have been affected.

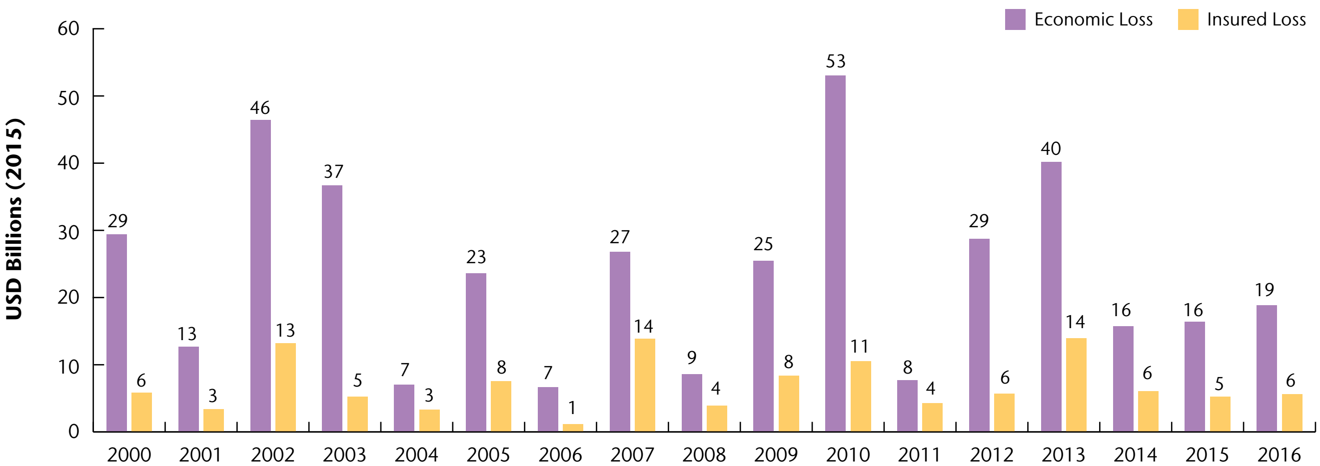
Of course, catastrophes do not follow national boundaries and because of this, Impact Forecasting is focusing on a pan-European flood event set to provide more insightful data to re/insurers with cross-country exposures.

Using the latest scientific and academic research, the team is combining two key approaches—global circulation models and observed flow and precipitation data—to understand the hydrological linkages between rainfall, run-off and inundation. Such an approach will lead to physically realistic and accurate flood risk evaluation on a pan-European level.

Impact Forecasting is working with Aon Benfield Research partners University of East Anglia and University of Cologne to build this next generation of flood models. This will help quantify all types of flood risk across Europe, with the ability to apply this approach in other territories, in the next two years.

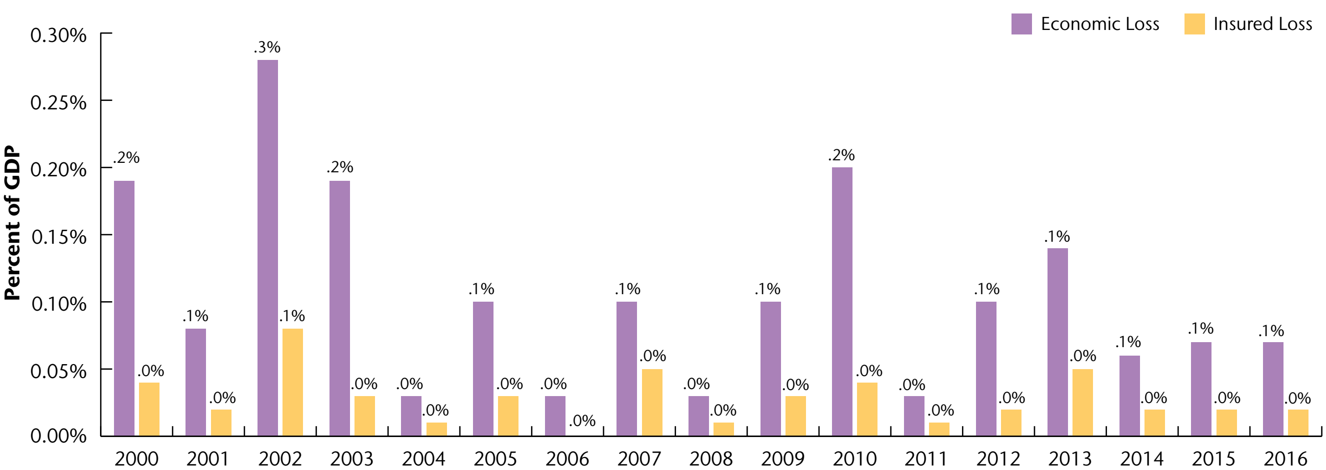
Using the latest scientific and academic research, Impact Forecasting is combining two key approaches—global circulation models and observed flow and precipitation data—to understand the hydrological linkages between rainfall, run-off and inundation.

Exhibit 51: EMEA Economic and Insured Losses



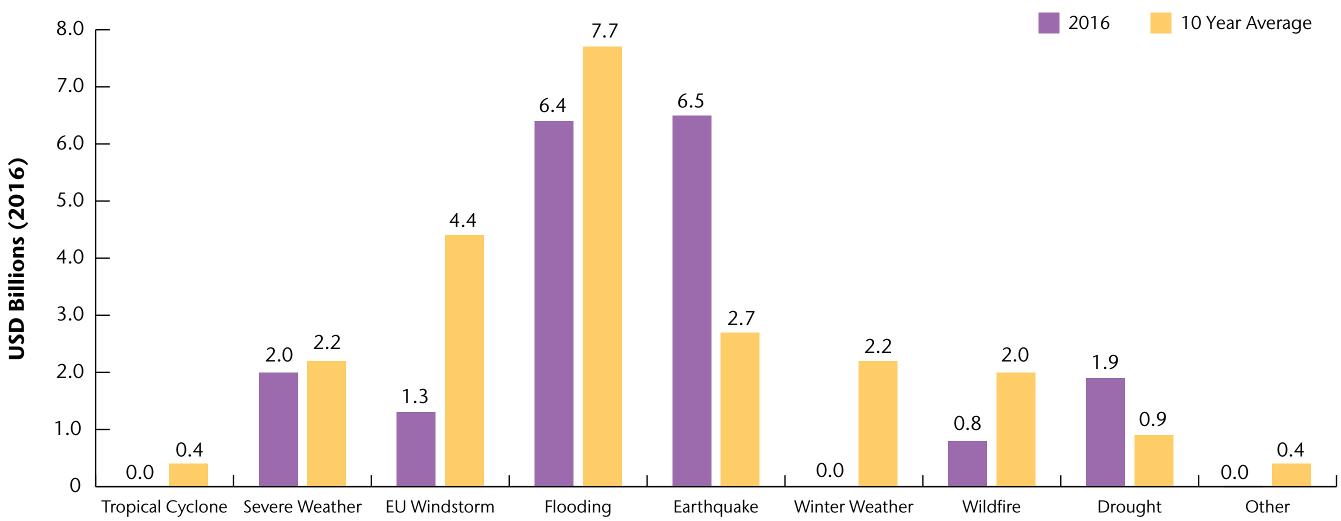
Since 1980, economic losses have increased by only 1.4 percent annually on an inflation-adjusted basis in EMEA. Insured losses have increased at a higher rate of 7.4 percent. The rate of growth is highly reduced when analyzing loss data for the past 16 years. On the economic loss side, losses trended downward annually by 0.3 percent; while insured losses have shown a minor growth trend of 1.8 percent annually since 2000.

Exhibit 52: EMEA Economic and Insured Losses as Percentage of GDP



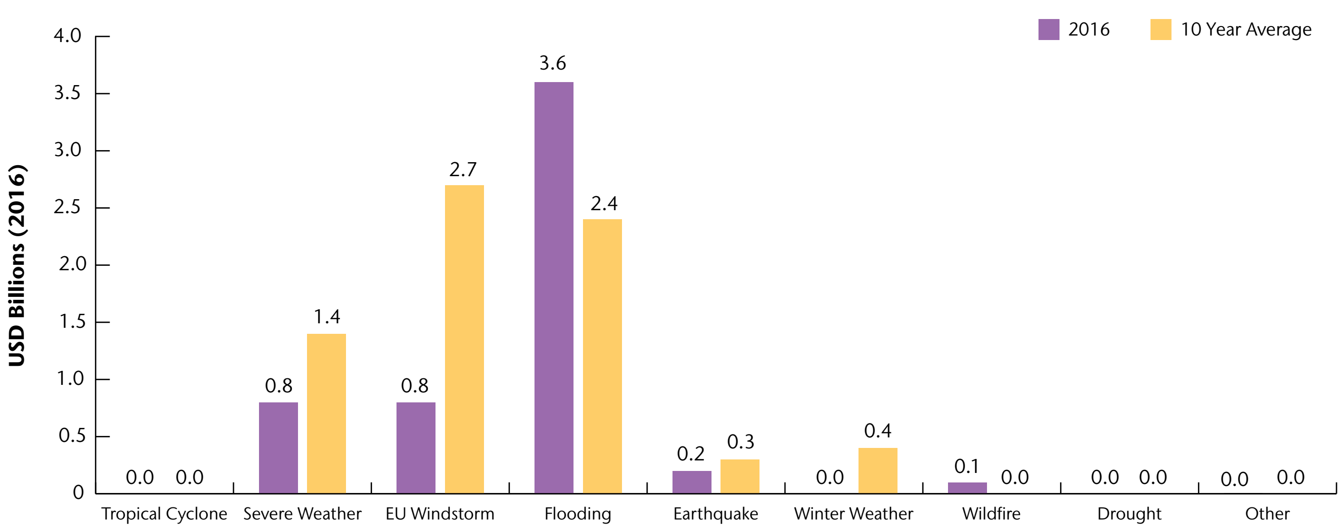
When analyzing natural disaster losses for EMEA as a percentage of GDP (World Bank), the rate of growth since 1980 has shown a slight downward trend in economic losses by 1.6 percent. Insured losses have annually shown a slight increase at the same rate of 1.6 percent. However, the loss-to-GDP ratio growth has actually been negative on an economic and insured loss basis since 2000. Economic losses have trended down by 3.7 percent and insured losses have trended slightly less at 1.6 percent. It remains important to point out that overall losses as a percent of GDP remain very low. EMEA governments and the insurance industry remain well prepared to manage associated losses at this time.

Exhibit 53: EMEA Economic Losses by Peril: 2016 vs 10 Year Avg



The two costliest perils (earthquake and flooding) both caused total economic losses in excess of USD6.4 billion, making up 68 percent of all losses incurred in 2016. Earthquake losses, driven by events in Italy, surpassed their 10-year average by 141 percent, while drought peril exceeded its 10-year average by 107 percent. The rest of the major perils were well below normal, with European Windstorm losses being particularly lower by 71 percent.

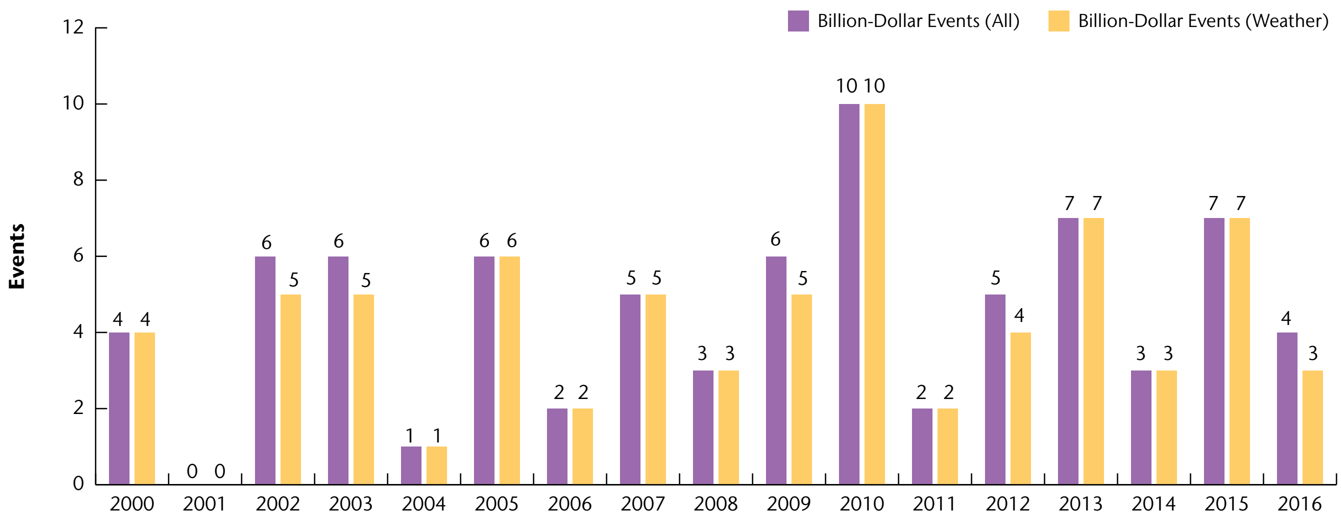
Exhibit 54: EMEA Insured Losses by Peril: 2016 vs 10 Year Avg



Flooding was the costliest peril of 2016 from the insured loss perspective, as it caused 68 percent of all industry losses and surpassed its 10-year average by more than 50 percent. Although significant in terms of total economic damage, earthquake peril did not generate exceptional insured loss due to a low market penetration in Italy and remained 29 percent below the 10-year average. European Windstorm was the second costliest peril, despite being 68 percent below the 10-year average of USD2.7 billion.

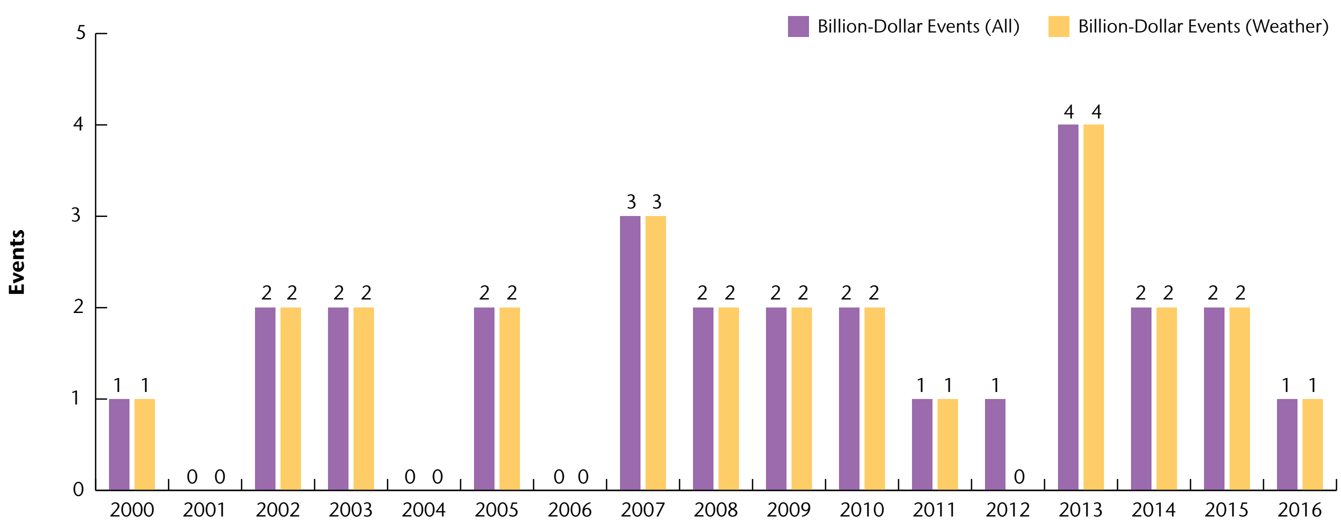
Please note that insured losses include those sustained by private insurers and government-sponsored programs.

Exhibit 55: EMEA Billion-Dollar Economic Loss Events (Inflated)



There were four natural disasters in EMEA region that caused at least USD1.0 billion in economic losses in 2016, one event below the 10-year average of five. Three of these disasters were weather-related. All four events were caused by four different perils: flooding, earthquake, drought and severe weather. 2016 was the first calendar year since 2009 without at least two billion-dollar flood events in EMEA.

Exhibit 56: EMEA Billion-Dollar Insured Loss Events (Inflated)



Flooding that impacted Western and Central Europe in spring 2016 was the only disaster that incurred more than USD1.0 billion of insured losses in EMEA region last year. This was one event below the 10-year average of two. The flooding was also the single costliest natural disaster in EMEA since the devastating Central European floods of 2013.

APAC (Asia & Oceania)

Exhibit 57: Top 5 Most Significant Events in APAC

Date(s)	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
April 14 - 16	Earthquake(s)	Japan	154	38 billion	5.5 billion
Summer	Flooding	China	475	28 billion	750 million
Yearlong	Drought	China	N/A	6.0 billion	200 million
Yearlong	Drought	India	N/A	5.0 billion	750 million
November 13	Earthquake	New Zealand	2	3.5 billion	2.1 billion
		All Other Events	~4,735	35 billion	2.7 billion
		Totals	**~5,365**	**116 billion[1]**	**12 billion[1,2]**

Economic and insured losses derived from natural catastrophes in APAC (Asia-Pacific) were both substantially higher than the 2000-2015 norm and the highest since the record year of 2011. The region incurred the highest economic costs resulting from natural disasters in the world. Economic losses (USD116 billion) in 2016 were 50 percent above the 2000-2015 average and insured losses (USD12 billion) were 27 percent higher. Conducting loss analyses on a median basis produced far more striking results. This plays into how the loss averages are heavily skewed given outlier years such as 2011. When analyzing economic losses on a median level since 2000, they were 181 percent higher. Insured losses were an even more substantial 254 percent higher than the median during the same timeframe.

The costliest single event in Asia-Pacific was a series of earthquakes that struck Japan's Kumamoto prefecture on April 14 and April 16. The main tremor was registered at magnitude-7.0 on April 16; while a damaging magnitude-6.2 event on April 14 was determined to be a foreshock. Widespread structural damage occurred to more than 186,600 homes, businesses and public facilities on Kyushu Island. Fires, landslides, and liquefaction caused additional damage, while shaking caused damage to the transportation infrastructure. Elsewhere, significant earthquakes occurred in New Zealand in November and Taiwan in February. Economic losses due to New Zealand's Kaikoura earthquake on November 13 were expected to reach USD3.5 billion: 60 percent of which was expected to be covered by insurance. Taiwan's Kaohsiung earthquake on February 6 claimed almost 120 lives and prompted economic losses of USD750 million.

The flood peril left a heavy financial toll in China in 2016. The most notable event occurred during the summer months and affected much of the Yangtze River Basin region. The El Niño-enhanced Mei Yu rains led to catastrophic flooding in eleven provinces. At least 475 fatalities resulted and an estimated 500,000 homes were impacted. Economic losses reached USD28 billion; less than three percent of which was covered by insurance. Other significant flood events were noted in northeastern China (July), southeastern Australia (September), and throughout India during the summer monsoon season.

The drought peril also left a substantial financial toll in portions of the region. Multi-billion dollar economic loss drought events were noted in China, India, and Thailand.

Five tropical cyclones prompted economic losses of at least USD1.0 billion. These were February's Cyclone Winston (Fiji), May's Cyclone Roanu (Sri Lanka), July's Super Typhoon Nepartak (Taiwan and China), Super Typhoon Meranti in September (Taiwan and China) and Super Typhoon Chaba in October (South Korea).

For a detailed review of all events in 2016, please visit www.**aonbenfield.com/catastropheinsight** and click on "Thought Leadership" to download updated monthly Global Catastrophe Recaps.

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

Bridging the Catastrophe Protection Gap

George Attard
Head of Aon Benfield Analytics International

While catastrophes have caused USD5.0 trillion in damage in the last 36 years, just USD1.2 trillion (2016 USD)—or 25 percent—has been covered by public or private insurance entities. This means that there remains a significant opportunity for the insurance industry to expand coverage and bridge the catastrophe protection gap – the difference between economic and insured losses.

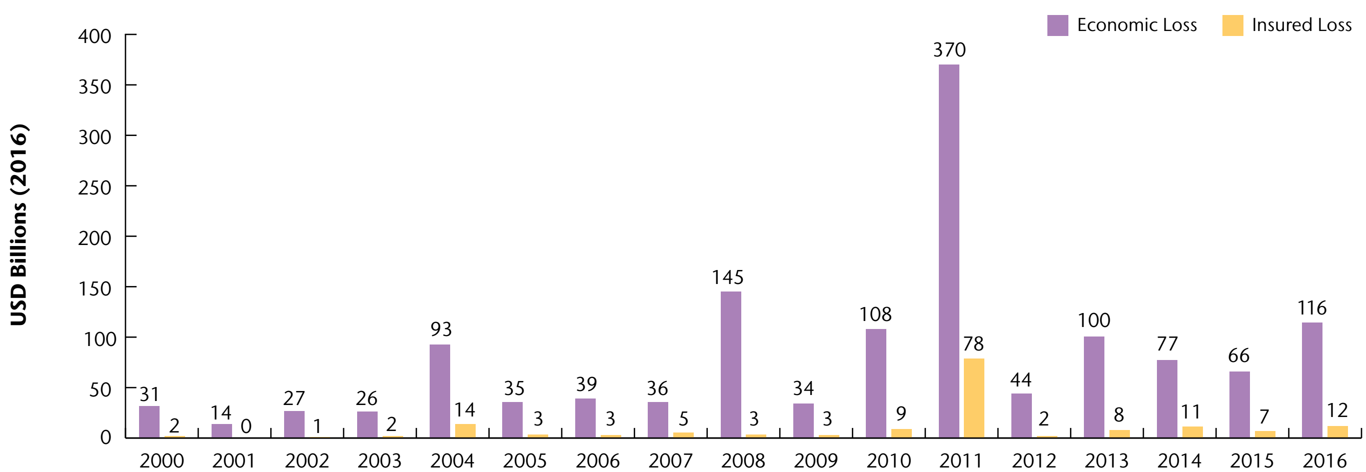
As we have seen with the Yangtze Basin floods in China this year where less than 3 percent of the USD28 billion of economic losses were insured, emerging economies in Asia Pacific remain particularly vulnerable in the aftermath of a major catastrophe. This is due to the impact of population growth, rapid urbanization, and high value risk concentrations.

In order to address the protection gap, the Insurance Development Forum (IDF) was established in April 2016 by the United Nations, the World Bank and the insurance industry to incorporate the latter's risk measurement know-how into existing governmental disaster risk reduction and resilience frameworks.

In 2017 we will see further development of a sustainable framework that promotes risk understanding and quantification to increase demand for, and efficient supply of disaster risk financing solutions.

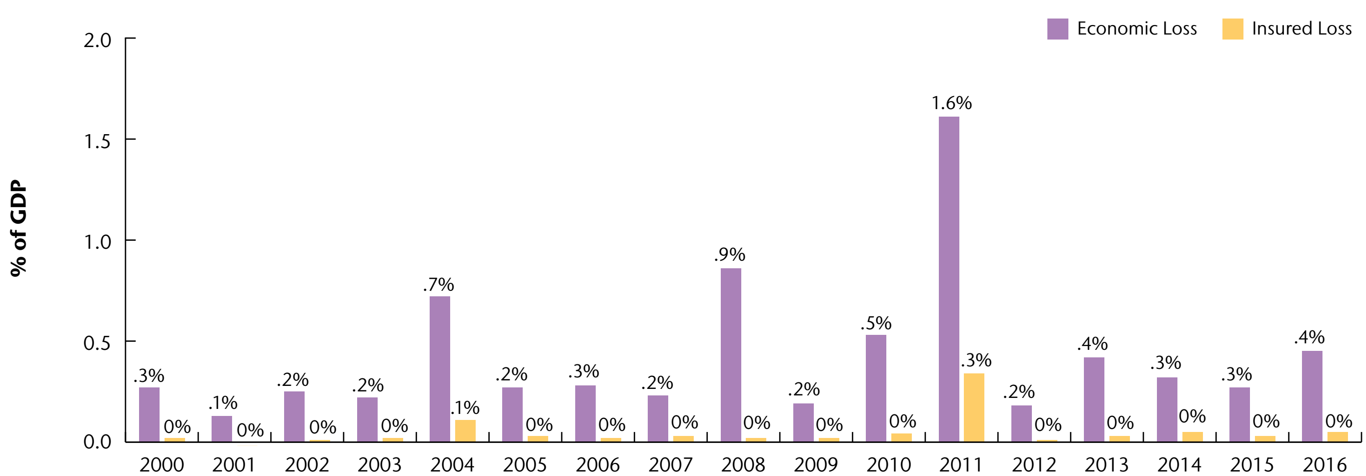
As we have seen with the Yangtze Basin floods in China this year where less than 3 percent of the USD28 billion of economic losses were insured, emerging economies in Asia Pacific remain particularly vulnerable in the aftermath of a major catastrophe.

Exhibit 58: APAC Economic and Insured Losses



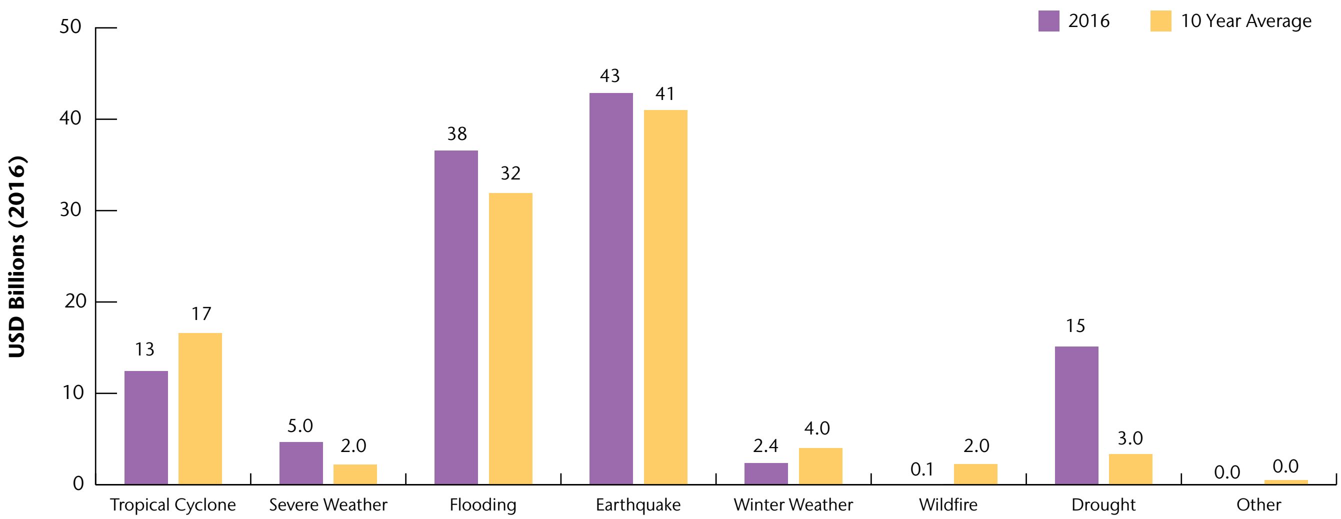
Since 1980, economic losses in Asia Pacific have shown an annual increase of 8.1 percent while insured losses have grown at a slightly faster 12.5 percent rate. Outside of the outlier years of 1995 and 2011, economic losses have not shown exponential growth over time. With insurance penetration continuing to expand across emerging markets in Asia Pacific (most notably in parts of the Far East), it is unsurprising that insured losses have grown at a faster rate since 1980. When looking solely at the last 16 years, economic losses have trended higher at 10.5 percent annual rate. Insured losses have shown a 15.5 percent annual rate of growth.

Exhibit 59: APAC Economic and Insured Losses as Percentage of GDP



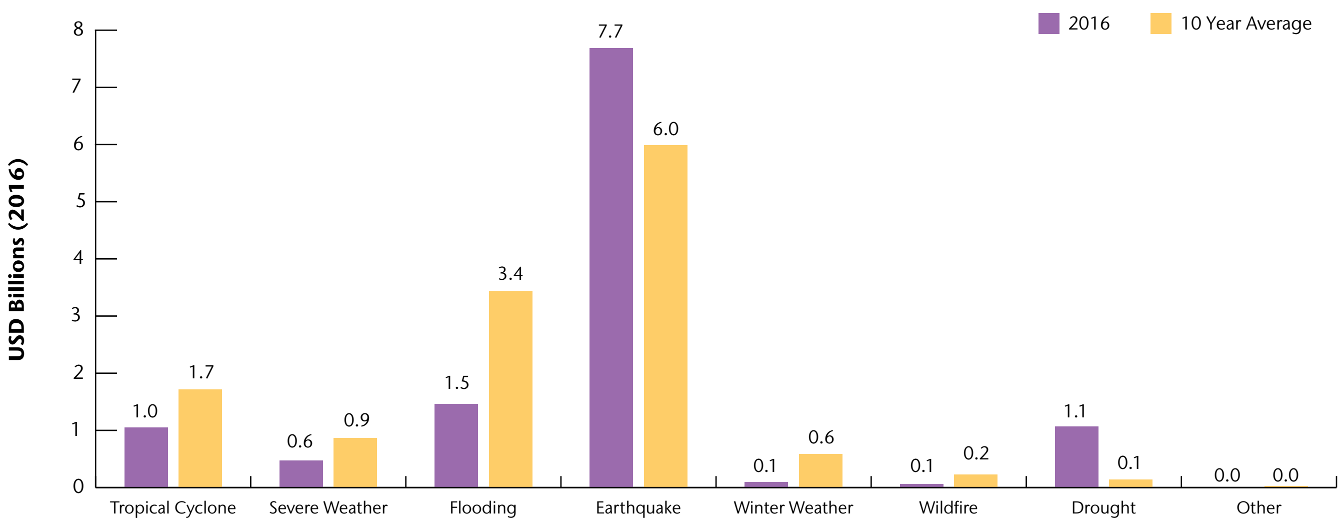
When analyzing natural disaster losses for Asia Pacific as a percentage of GDP (World Bank), the rate of growth since 1980 has increased annually by 3.7 percent for economic losses and 7.9 percent for insured losses. During the past 16 years (since 2000), economic and insured losses have shown similar rates of annual growth at 3.7 and 8.5 percent respectively. Asia Pacific economies include some of the fastest growing in the world and this has likely had an impact in recent years in regards to the smaller percentages of natural disaster loss to GDP growth. Despite the large loss values, only in 2011 did the economic loss-to-GDP ratio surpass 1.0 percent.

Exhibit 60: APAC Economic Losses by Peril: 2016 vs 10 Year Avg



The two costliest perils (earthquake and flooding) caused the vast majority of economic losses in Asia Pacific during 2016, combining to equal 70 percent of the regional damage. Both of these perils plus drought and severe weather (thunderstorm) all surpassed their recent ten-year averages. Drought surpassed its recent ten-year average by more than 400 percent. Wildfire, winter weather, and tropical cyclone losses were all well below their 2006-2015 averages.

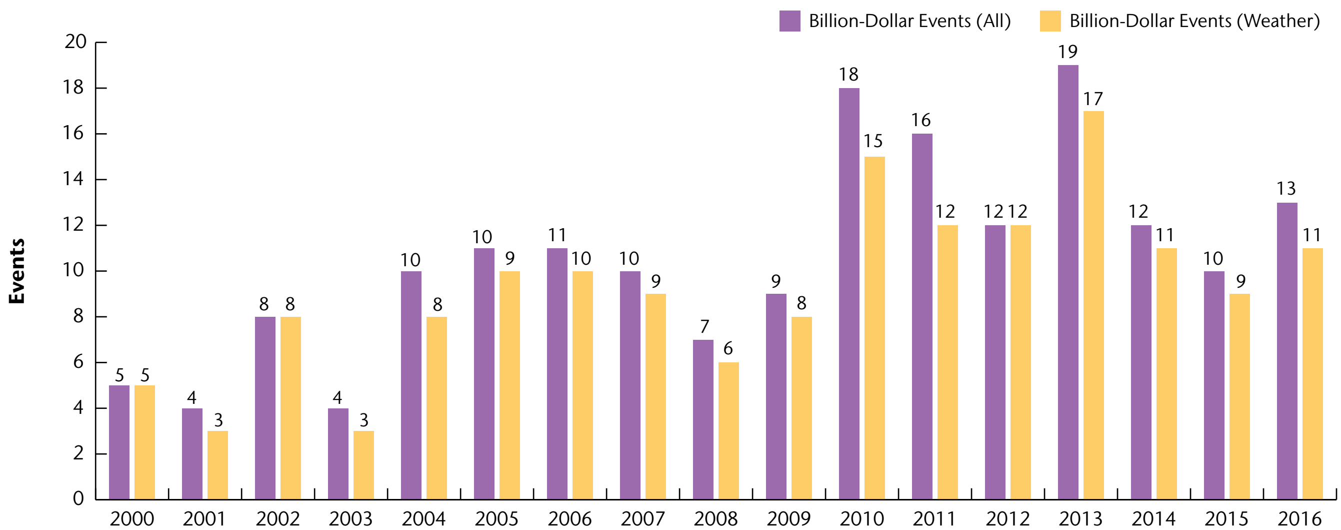
Exhibit 61: APAC Insured Losses by Peril: 2016 vs 10 Year Avg



Just two perils (drought and earthquake) sustained above-average losses in 2016. Earthquake was the costliest with USD7.7 billion in payouts from the industry predominantly due to large events in Japan and New Zealand. Flooding was second costliest with payouts equaling USD1.5 billion despite being below the 2006-2015 average of USD3.4 billion. Earthquake, flooding, drought, and tropical cyclone were the only perils to incur insured losses in excess of USD1.0 billion in 2016. It remains worth noting that despite the very high economic cost of natural disasters in the region, only slightly more than 10 percent of disaster losses in 2016 were covered by insurance.

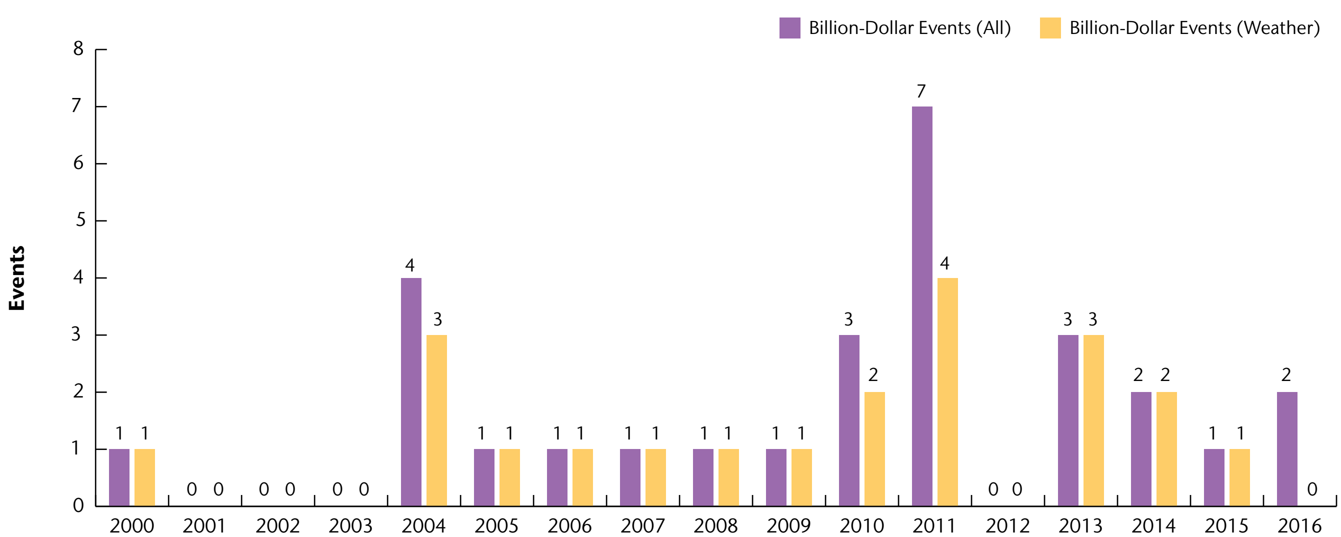
Please note that insured losses include those sustained by private insurers and government-sponsored programs.

Exhibit 62: APAC Billion-Dollar Economic Loss Events (Inflated)



There were 13 separate natural disaster events that caused more than USD1.0 billion in 2016 economic losses in Asia Pacific, which was above the 2000-2015 average of 10. This follows the 10 that occurred in 2015. In terms of weather only billion-dollar events, there were 11 such instances. This was also above the 16-year-average (nine). The breakdown of billion-dollar event perils types included tropical cyclone (five), drought (three), flooding (two), earthquake (two), and winter weather (one).

Exhibit 63: APAC Billion-Dollar Insured Loss Events (Inflated)



There were two natural disaster events that triggered insured losses beyond USD1.0 billion in 2016, which was equal to the 16-year average. The events that exceeded the threshold were major earthquakes in Japan and New Zealand. No weather events came close to the USD1.0 billion threshold: the closest were a major flooding event in China's Yangtze River Basin region and a year-long drought in India that each incurred insured losses of USD750 million.

Appendix A: 2016 Global Disasters

Exhibit 64: United States

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-12/31	Drought	Nationwide	N/A	Unknown	3.5+ billion
01/04-01/08	Flooding	California	0	10,000+	125+ million
01/09	Severe Weather	Florida	0	200+	10+ million
01/17	Severe Weather	Florida	2	200+	20+ million
01/21-01/24	Winter Weather	Mid-Atlantic, Northeast, Southeast	58	25,000+	1.0+ billion
01/31-02/01	Severe Weather	California	0	12,500+	175+ million
02/01-02/03	Winter Weather	Plains, Midwest, Northeast	1	5,000+	100+ million
02/08-02/09	Winter Weather	Northeast, Mid-Atlantic	0	2,000+	25+ million
02/13	Earthquake	Oklahoma	0	500+	Unknown
02/13-02/16	Winter Weather	Northeast, Midwest, Southeast	6	20,000+	700+ million
02/19-02/20	Severe Weather	Midwest	0	25,000+	250+ million
02/22-02/25	Severe Weather	Plains, Midwest, Southeast, Northeast	10	100,000+	1.2+ billion
02/29-03/01	Severe Weather	Plains, Southeast	0	5,000+	25+ million
03/04-03/12	Severe Weather	Plains, Southeast, Midwest, West	6	60,000+	1.5+ billion
03/13-03/14	Severe Weather	Plains, Midwest, Southeast	0	20,000+	175+ million
03/13-03/15	Severe Weather	West, Midwest, Plains	1	10,000+	175+ million
03/17-03/18	Severe Weather	Plains, Southeast	0	135,000+	1.4+ billion
03/22-03/25	Severe Weather	Rockies, Plains, Southeast, Midwest	0	175,000+	2.5+ billion
03/26-03/27	Severe Weather	Midwest, Southeast	0	10,000+	75+ million
03/30-04/01	Severe Weather	Plains, Southeast, Midwest	0	20,000+	200+ million
04/02-04/04	Severe Weather	Midwest, Mid-Atlantic, Northeast	2	60,000+	450+ million
04/06-04/07	Severe Weather	Southeast, Midwest	0	2,000+	10+ million
04/10-04/15	Severe Weather	Plains, Southeast	1	350,000+	4.3+ billion
04/15-04/19	Flooding	Plains, Rockies	9	70,000+	2.0+ billion
04/24-04/28	Severe Weather	Plains, Midwest, Southeast, Mid-Atlantic	1	100,000+	800+ million
04/29-05/03	Severe Weather	Plains, Midwest, Southeast, Mid-Atlantic	6	150,000+	1.8+ billion
05/07-05/10	Severe Weather	Plains, Midwest, Mississippi Valley	2	90,000+	1.0+ billion
05/11-05/12	Severe Weather	Plains, Midwest	0	90,000+	950+ million
05/16-05/19	Severe Weather	Texas, Oklahoma	0	17,000+	175+ million
05/21-05/28	Severe Weather	Plains, Midwest	9	100,000+	1.3+ billion
05/29-06/02	Severe Weather	Plains	12	25,000+	300+ million
06/06-06/07	Severe Weather	Colorado	0	15,000+	175+ million
06/16-06/18	Severe Weather	Mid-Atlantic, Southeast, Northeast	0	20,000+	275+ million
06/16-06/18	Severe Weather	Plains, Midwest	0	17,500+	175+ million

Exhibit 64: United States (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
06/22-06/26	Severe Weather	Mid-Atlantic, Midwest	23	25,000+	750+ million
06/23-06/30	Wildfire	California	2	2,000+	150+ million
06/27-06/29	Severe Weather	Rockies, Plains	0	10,000+	200+ million
07/05-07/07	Severe Weather	Plains, Midwest, Mid-Atlantic, Southeast	0	20,000+	200+ million
07/07-07/09	Severe Weather	Rockies, Midwest, Southeast	0	40,000+	375+ million
07/13-07/15	Severe Weather	Rockies, Plains, Midwest, Southeast	7	50,000+	500+ million
07/19-07/21	Severe Weather	Midwest, Ohio Valley	3	10,000+	125+ million
07/20-07/21	Severe Weather	Midwest	0	10,000+	140+ million
07/22-08/01	Wildfire	California	2	250+	50+ million
07/22-09/30	Wildfire	California	1	100+	250+ million
07/28-07/29	Severe Weather	Rockies, Plains	0	115,000+	1.6+ billion
07/30-08/01	Flooding	Mid-Atlantic, Northeast	2	15,000+	700+ million
08/02-08/04	Flooding	Desert Southwest	0	Thousands	10s of millions
08/09-08/16	Flooding	Louisiana, Mississippi, MS Valley	13	250,000+	10 to 15 billion
08/13-08/31	Wildfires	West	0	Thousands	100+ million
08/13-08/31	Wildfire	California	0	2,000+	100+ million
08/16-08/31	Wildfire	California	0	2,000+	100+ million
08/23-08/24	Flooding	Midwest	1	Thousands	100+ million
08/24-08/25	Severe Weather	Midwest	0	3,500+	125+ million
09/01-09/08	HU Hermine	Southeast, Mid-Atlantic	1	50,000+	700+ million
09/03	Earthquake	Oklahoma	0	Hundreds	10s of millions
09/21-09/30	Flooding	Iowa, Wisconsin, Minnesota	1	30,000+	550+ million
10/07-10/09	HU Matthew	Southeast, Mid-Atlantic	49	500,000+	Up to 10 billion
10/12-10/16	Severe Weather	Pacific Northwest	0	10,000+	75+ million
11/04-11/06	Severe Weather	Texas, New Mexico	0	45,000+	450+ million
11/06	Earthquake	Oklahoma	0	50+	10s of millions
11/16-11/22	Winter Weather	Plains, Midwest, Mid-Atlantic, Northeast	6	Thousands	10s of millions
11/26-12/01	Severe Weather	Southeast, Plains, Midwest, Rockies	5	25,000+	275+ million
11/28-12/07	Wildfires	Tennessee	13	4,000+	900+ million
12/10-12/13	Winter Weather	Plains, Midwest, Northeast	9	Thousands	Millions+
12/13-12/19	Winter Weather	Northern United States	22	10,000+	100+ million
12/23-12/26	Winter Weather	United States	4	10,000+	50+ million

Exhibit 65: Remainder of North America (Canada, Mexico, Central America, Caribbean Islands)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-02/29	Drought	Haiti	0	Unknown	84+ million
02/23-02/25	Winter Weather	Canada	0	5,000+	25+ million
02/28	Flooding	Haiti	5	10,000+	Millions
03/09-03/10	Severe Weather	Canada	1	5,000+	50+ million
03/24-03/25	Winter Weather	Canada	0	10,000+	100+ million
04/23-04/24	Flooding	Haiti	6	4,400+	Unknown
04/27-05/01	Flooding	Haiti, Dominican Republic	1	2,500+	Millions
05/02-05/31	Wildfire	Canada	0	35,000+	4.5+ billion
05/26-05/31	Flooding	Haiti	1	2,900+	Unknown
06/09	Earthquake	Nicaragua, Honduras	0	3,000+	Millions
06/24-06/25	Severe Weather	Canada	0	5,000+	44+ million
06/28-06/30	Severe Weather	Canada	0	9,100+	87+ million
07/08	Severe Weather	Canada	0	4,500+	52+ million
07/08-07/11	Severe Weather	Canada	0	5,200+	57+ million
07/15-07/16	Severe Weather	Canada	0	7,000+	80+ million
07/18-07/20	Severe Weather	Canada	0	10,000+	100+ million
07/22	Severe Weather	Canada	0	6,300+	95+ million
07/27	Severe Weather	Canada	0	7,000+	67+ million
07/30-08/01	Severe Weather	Canada	0	42,000+	435+ million
08/02-08/10	HU Earl	Mexico, Central America, Caribbean	67	15,000+	250+ million
09/06-09/08	HU Newton	Mexico	11	2,000+	50+ million
09/14-09/18	Flooding	Mexico	13	2,000+	Unknown
09/28-09/30	Flooding	Canada	0	6,000+	175+ million
09/29-09/30	Flooding	Mexico	5	2,000+	25+ million
09/28-10/07	HU Matthew	Caribbean	552+	250,000+	5.5+ billion
10/09-10/10	HU Matthew	Canada	0	Thousands	10s of millions
10/13	HU Nicole	Bermuda	0	Hundreds	Millions
10/18-10/20	Flooding	Central America	10	95,000+	100+ million
11/01-11/11	Flooding	Dominican Republic	0	4,100+	Unknown
11/03-11/06	Flooding	Mexico	2	20,000+	Unknown
11/05-11/06	Flooding	Haiti	10	1,000+	Unknown
11/22-11/26	HU Otto	Panama, Costa Rica, Nicaragua	17	20,000+	50+ million

Exhibit 66: South America

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-01/25	Flooding	Ecuador	9	2,000+	10+ million
01/09-01/15	Flooding	Brazil	3	25,000+	100+ million
02/20-02/25	Flooding	Peru	1	2,000+	Millions
03/10-03/11	Flooding	Brazil	30	5,000+	100+ million
04/04-04/10	Flooding	Argentina, Uruguay	0	7,500+	1.3+ billion
04/15-04/18	Flooding	Chile	12	5,000+	100+ million
04/15-04/18	Severe Weather	Uruguay	8	5,000+	25+ million
04/16	Earthquake	Ecuador	673	25,000+	3.4+ billion
08/14	Earthquake	Peru	4	2,600+	Unknown
11/26-12/05	Flooding	Bolivia, Colombia, Venezuela	15	550+	Unknown
12/25-12/26	Flooding	Argentina	0	3,400+	Millions+

Exhibit 67: Europe

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-01/08	Winter Weather	Central & Northern Europe	22	Unknown	Unknown
01/12-01/14	Winter Weather	Central & Northern Europe	3	1,000+	25+ million
01/25	Earthquake	Spain, Morocco	1	2,000+	13+ million
01/29-01/30	WS Marita	UK, Scandinavia	1	10,000+	275+ million
02/01-02/02	WS Norkys	United Kingdom	0	Thousands	75+ million
02/08	WS Ruzica	UK, France, Scandinavia	0	Thousands	275+ million
02/27-02/29	Severe Weather	Italy	6	5,000+	25+ million
03/01-03/02	WS Aloisia	UK, Ireland	3	2,000+	160+ million
03/06-03/08	Flooding	Serbia, Croatia, Montenegro	0	1,000+	100+ million
03/09-03/10	Flooding	United Kingdom	0	1,000+	50+ million
03/27-03/29	WS Jeanne	UK, Scandinavia	1	25,000+	300+ million
04/16-04/22	Flooding	Russia	0	8,000+	Millions
05/23-06/01	Severe Weather	Czech Republic	0	24,000+	80+ million
05/26-06/06	Flooding	Germany, France, Austria, Poland	20	250,000+	5.5+ billion
06/04-06/06	Severe Weather	Russia	0	3,000+	10+ million
06/23-06/24	Severe Weather	Netherlands	0	5,000+	1.1+ billion
07/22	Flooding	Luxembourg	0	Thousands	50+ million
08/06-08/07	Flooding	Macedonia	22	5,000+	75+ million
08/08-08/20	Wildfires	Portugal, France, Spain	5	1,000+	250+ million
08/24	Earthquake	Italy	299	25,000+	5.0+ billion
09/06-09/07	Flooding	Greece	4	10,000+	56+ million
09/11	Earthquake	Macedonia	0	Hundreds	10+ million

Exhibit 67: Europe (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
10/26	Earthquake	Italy	1	Thousands	100s of Millions
10/30	Earthquake	Italy	0	Thousands	100s of Millions
11/05-11/07	Severe Weather	Italy	2	Thousands	10s of millions
11/18-11/26	Wildfires	Israel	0	1,706+	520+ million
11/20-11/21	WS Nannette	Western Europe	0	25,000+	175+ million
11/23-11/25	Flooding	Italy, France	2	Thousands	106+ million
12/04	Flooding	Spain	2	10,000+	105+ million
12/16-12/19	Flooding	Spain	6	10,000+	50+ million
12/23-12/27	WS Antje & Barbara	Western & Northern Europe	0	Thousands	100+ million

Exhibit 68: Africa

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-01/10	Heatwave	South Africa	11	Unknown	Unknown
01/01-02/15	Flooding	Burundi	52	5,100+	13+ million
01/01-03/31	Drought	Namibia	0	Unknown	60+ million
01/01-06/30	Drought	South Africa	0	Unknown	250+ million
01/01-06/30	Drought	Zimbabwe	0	Unknown	1.6+ billion
02/29	Flooding	Angola	54	5,000+	Unknown
03/06-03/09	Flooding	Angola	6	550+	Unknown
03/10	Flooding	Kenya	3	1,000+	Unknown
04/02-04/07	Flooding	Ethiopia	28	1,000+	Unknown
04/06-04/11	Flooding	Somalia, Malawi	19	10,000+	Millions
04/12-04/18	Flooding	Tanzania	3	3,000+	Unknown
04/13-04/17	Flooding	Uganda	0	5,000+	2.7+ million
04/16-04/22	Flooding	Angola	19	5,000+	Unknown
04/29-05/02	Flooding	Kenya	39	2,000+	Unknown
05/07-05/08	Landslide	Rwanda	50	500+	Unknown
05/09	Landslide	Ethiopia	100	Unknown	Unknown
06/01-07/31	Flooding	Niger	11	2,000+	Unknown
06/13	Flooding	Ghana	10	Unknown	Unknown
07/01-08/31	Flooding	Sudan, South Sudan	114	41,000+	Unknown
07/12-08/09	Flooding	Mali, Burkina Faso	26	10,000+	Unknown
07/13-07/15	Flooding	Sudan	13	2,000+	Unknown
07/27	Severe Weather	South Africa	7	Thousands	180+ million
08/14-09/07	Severe Weather	Nigeria	28	15,000+	Unknown
09/10	Earthquake	Tanzania	23	16,500+	458+ million

Exhibit 68: Africa (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
09/20	Flooding	Nigeria	29	17,500+	Unknown
10/27-10/29	Flooding	Egypt	28	10,000+	25+ million
11/09	Flooding	South Africa	6	5,000+	160+ million
12/09-12/14	Flooding	Zimbabwe	31	400+	Unknown
12/26-12/29	Flooding	Democratic Republic of Congo	50	500+	Unknown

Exhibit 69: Asia

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-03/31	Drought	Philippines	0	Unknown	41+ million
01/01-06/30	Drought	India	0	Unknown	5.0+ billion
01/01-06/30	Drought	Vietnam	0	Unknown	675+ million
01/01-06/30	Drought	Thailand	0	Unknown	3.3+ billion
01/03	Earthquake	India	22	1,000+	75+ million
01/21	Earthquake	China	0	2,200+	15+ million
01/20-01/26	Winter Weather	China, Taiwan, Korea, Japan, Thailand	116	25,000+	2.0+ billion
01/26-01/29	Flooding	China	11	1,000+	20+ million
02/01-05/02	Wildfire	India, Nepal	18	Unknown	Unknown
02/03	Winter Weather	India	10	Unknown	Unknown
02/05-02/09	Flooding	Indonesia	6	4,000+	Millions
02/06	Earthquake	Taiwan	117	Thousands	750+ million
02/18-02/19	Severe Weather	China	0	1,600+	62+ million
02/19-02/24	Flooding	Indonesia, Malaysia	1	7,200+	Millions
02/21-02/26	Winter Weather	China	0	1,000+	15+ million
03/03-03/09	Severe Weather	China	0	4,000+	315+ million
03/07-03/08	Flooding	Indonesia	6	2,500+	Unknown
03/07-03/11	Winter Weather	China	0	1,000+	140+ million
03/08-03/11	Severe Weather	United Arab Emirates, Oman	0	15,000+	500+ million
03/09-03/29	Flooding	Pakistan	141	1,100+	Millions
03/13	Flooding	Indonesia	5	5,900+	Unknown
03/19-03/22	Severe Weather	China	13	82,000+	170+ million
03/25-03/28	Severe Weather	China	0	2,000+	77+ million
03/26-03/29	Winter Weather	China	0	Unknown	146+ million
04/01-04/08	Flooding	China	10	30,000+	45+ million
04/01-04/15	Heatwave	India	300	Unknown	Unknown
04/02-04/08	Flooding	Pakistan, Afghanistan	152	5,000+	Millions
04/08-04/15	Flooding	Saudi Arabia, Yemen, Oman	47	25,000+	100+ million
04/10-04/12	Severe Weather	China	8	22,000+	130+ million
04/13	Earthquake	Myanmar, Bangladesh, India	2	Hundreds	Unknown

Exhibit 69: Asia (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
04/14 & 04/16	Earthquake	Japan	154	260,000+	38+ billion
04/16-04/17	Flooding	Afghanistan	31	Unknown	Unknown
04/16-04/19	Severe Weather	China	6	2,000+	14+ million
04/20-04/28	Flooding	China	20	16,000+	97+ million
04/21-04/23	Severe Weather	Myanmar	8	10,000+	Millions
04/22-04/25	Flooding	India	18	10,000+	150+ million
04/24-04/27	Severe Weather	China	0	2,000+	216+ million
04/28-05/03	Flooding	China	3	6,000+	31+ million
04/29-05/03	Severe Weather	Myanmar	18	17,900+	2.6+ million
05/01-05/05	Severe Weather	China	4	31,500+	115+ million
05/01-08/31	Flooding	China	475	1,000,000+	28+ billion
05/09-05/12	Flooding	Tajikistan, Afghanistan	10	5,000+	Unknown
05/10-05/15	Flooding	Indonesia	20	Thousands	Unknown
05/12-05/14	Severe Weather	Bangladesh, India, Myanmar	67	Unknown	Unknown
05/14-05/15	Severe Weather	China	1	1,300	93+ million
05/14-05/23	CY Roanu	Sri Lanka, Southern Asia	135	200,000+	1.8+ billion
05/19	Severe Weather	China	0	Unknown	91+ million
05/22	Landslide	India	10	Unknown	Unknown
05/22	Landslide	Yemen	20	100	Unknown
05/22	Earthquake	China	0	46,200	Unknown
05/22-05/23	Winter Weather	China	0	Unknown	61+ million
05/24-05/30	Severe Weather	China	0	5,000+	354+ million
06/01	Severe Weather	Pakistan	15	Unknown	Unknown
06/01-08/31	Drought	China	0	N/A	6.0+ billion
06/02-6/08	Severe Weather	China	12	50,000+	768+ million
06/06-06/14	Severe Weather	China	4	21,000+	764+ million
06/08-06/11	Flooding	Myanmar	12	10,000+	Unknown
06/12	Severe Weather	India	11	Unknown	Unknown
06/16-06/23	Severe Weather	China	102	50,000+	500+ million
06/17-06/21	Flooding	Indonesia	62	25,000+	25+ million
06/20-06/21	Severe Weather	India	93	Unknown	Unknown
06/20-06/23	Flooding	Japan	7	2,000+	100+ million
06/25-07/01	Flooding	India	55	10,000+	100+ million
06/26-06/29	Severe Weather	China	1	5,000+	165+ million
06/30-07/01	Flooding	Indonesia	0	14,100+	Unknown
07/01-07/03	Severe Weather	China	0	5,000+	117+ million
07/01-07/15	Flooding	India	90	125,000+	100+ million

Exhibit 69: Asia (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
07/02-07/15	Flooding	Pakistan	46	100+	Unknown
07/08-07/11	Severe Weather	China	4	5,000+	50+ million
07/08-07/12	STY Nepartak	Philippines, Taiwan, China	78	50,000+	1.4+ billion
07/16-07/24	Flooding	China	289	500,000+	4.7+ billion
07/19	Flooding	Afghanistan	17	Unknown	Unknown
07/21-07/27	Flooding	Nepal	66	5,000+	Unknown
07/22-07/24	Flooding	North Korea	14	250	Unknown
07/22-08/04	Flooding	Bangladesh	60	255,000+	50+ million
07/24	Flooding	Indonesia	4	2,600+	Unknown
07/24	Severe Weather	China	4	10,000+	50+ million
07/24-08/19	Flooding	India	484	150,000+	150+ million
07/25-08/12	Flooding	Myanmar	6	45,000+	Millions
07/27-07/28	TS Mirinae	China, Vietnam	5	2,000+	30+ million
07/28-07/31	Flooding	China	4	7,000	91 million
07/28-08/01	Severe Weather	China	3	2,400+	21+ million
07/31-08/03	Flooding	China	5	3,000+	142+ million
07/31-08/03	TY Nida	Philippines, China, Vietnam	0	20,000+	272+ million
08/02-08/05	Flooding	Vietnam	12	1,000+	10+ million
08/04-08/07	Severe Weather	China	19	4,800+	23+ million
08/05-08/08	Flooding	Pakistan	32	580+	Unknown
08/05-08/10	Flooding	China	23	12,300+	130+ million
08/07-08/10	Flooding	India	13	15,000+	25+ million
08/08-08/16	Flooding	Philippines	22	Thousands	10+ million
08/15-08/16	Flooding	Thailand	3	7,500+	10+ million
08/18-08/22	TS Dianmu	China, Vietnam	12	3,500+	550+ million
08/19-08/22	Flooding	India	40	25,000+	312+ million
08/20-08/25	Flooding	China	2	11,400+	96+ million
08/20-08/25	Flooding	China	1	12,000+	165+ million
08/20-08/25	Severe Weather	China	0	400+	70+ million
08/22-08/23	TS Mindulle	Japan	2	5,000+	100+ million
08/24	Earthquake	Myanmar	4	5,000+	10+ million
08/26-08/30	Flooding	China	8	8,400+	76+ million
08/27-08/28	Flooding	Pakistan	10	Unknown	Unknown
08/30-09/01	TY Lionrock	Japan, China, Korean Peninsula	550+	50,000+	325+ million
09/04-09/06	Severe Weather	China	2	5,000+	69+ million
09/05-09/06	Severe Weather	China	0	6,400+	54+ million
09/08-09/13	Severe Weather	China	0	2,000+	175+ million

Exhibit 69: Asia (continued)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
09/12	Earthquake	South Korea	0	6,000+	21+ million
09/14-09/16	STY Meranti	China, Taiwan, Philippines	44	70,000+	2.5+ billion
09/18-09/22	Flooding	China	23	4,100+	21+ million
09/19-09/22	TY Malakas	Taiwan, Japan	1	5,000+	300+ million
09/20-09/22	Flooding	Indonesia	53	2,550+	22+ million
09/21-09/29	Flooding	India	28	40,000+	479+ million
09/26-09/29	TY Megi	China, Taiwan	43	25,000+	940+ million
10/1-10/10	Flooding	Thailand	4	88,000+	Millions
10/05-10/06	TY Chaba	South Korea, Japan	7	33,000+	1.0+ billion
10/13-10/15	TS Aere	Vietnam	34	132,000+	350+ million
10/16-10/19	TY Sarika	Philippines, China	2	25,000+	890+ million
10/19-10/21	STY Haima	Philippines, China	19	100,000+	968+ million
10/21	Earthquake	Japan	0	10,000+	100+ million
10/30-11/05	Flooding	Vietnam	2	87,000+	100+ million
10/31-11/02	Flooding	China	0	Unknown	65+ million
11/13-11/15	Flooding	Indonesia	0	5,800+	Unknown
11/25	Earthquake	China, Tajikistan	1	12,400+	5.5+ million
11/28-11/29	Flooding	Saudi Arabia	18	5,000+	50+ million
11/30-12/05	Flooding	Vietnam	26	50,000+	500+ million
11/30-12/07	Flooding	Indonesia	10	21,050+	10+ million
12/01-12/10	Flooding	Thailand	14	9,070+	25+ million
12/07	Earthquake	Indonesia	102	12,600+	67+ million
12/08	Earthquake	China	0	18,340+	135+ million
12/12	CY Vardah	India	12	25,000+	150+ million
12/12-12/20	Flooding	Vietnam	24	112,400+	650+ million
12/21-12/23	Flooding	Indonesia	0	Thousands	74+ million
12/25-12/26	STY Nock-Ten	Philippines	13	313,750+	123+ million

Exhibit 70: Oceania (Australia, New Zealand, and the South Pacific Islands)

Date(s)	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/03-01/05	Flooding	Australia (NSW)	0	500	25+ million
01/06-01/13	Bushfire	Australia (WA)	2	1,400+	100+ million
01/14	Severe Weather	Australia (NSW)	1	500+	25+ million
01/29-01/30	Severe Weather	Australia (NSW)	0	1,300+	27+ million
02/14	Earthquake	New Zealand	0	7,200+	50+ million
02/16-02/22	TC Winston	Fiji, Tonga	44	46,000+	1.4+ billion
03/23-03/24	Flooding	New Zealand	0	1,000+	25+ million
04/04-04/07	CY Zena	Fiji	2	2,000+	25+ million
06/04-06/06	Severe Weather	Australia	4	46,363	425+ million
07/16-07/17	Severe Weather	Australia (South Australia & Victoria)	0	2,000+	20+ million
08/22	Earthquake	Australia (Queensland)	0	1,000+	5+ million
09/13-09/15	Flooding	Australia (SA, VIC)	1	2,000+	25+ million
09/20-09/30	Flooding	Australia (NSW)	0	2,300+	765+ million
09/28-09/30	Severe Weather	Australia (SA)	0	5,000+	75+ million
10/08-10/09	Severe Weather	Australia (VIC)	1	5,000+	10+ million
11/11	Severe Weather	Australia	0	30,728+	250+ million
11/13	Earthquake(s)	New Zealand	2	15,075+	3.5+ billion
12/25-12/28	Severe Weather	Australia	0	2,000+	100+ million

Appendix B: Historical Natural Disaster Events

The following tables provide a look at specific global natural disaster events since 1950. (Please note that the adjusted for inflation (2016 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).

For additional top 10 lists, please visit **www.aonbenfield.com/catastropheinsight**

Exhibit 71: Top 10 Costliest Global Economic Loss Events (1950-2016)

Date	Event	Location	Economic Loss[1] Actual (USD)	Economic Loss[2] (2016 USD)
March 11, 2011	EQ/Tsunami	Japan	210 billion	225 billion
January 17, 1995	Earthquake	Japan	103 billion	163 billion
August 2005	Hurricane Katrina	United States	125 billion	152 billion
May 12, 2008	Earthquake	China	85 billion	94 billion
October 2012	Hurricane Sandy	US, Caribbean, Bahamas, Canada	72 billion	74 billion
January 17, 1994	Earthquake	United States	44 billion	72 billion
Nov. 23, 1980	Earthquake	Italy	19 billion	52 billion
July - Dec. 2011	Flooding	Thailand	45 billion	48 billion
August 1992	Hurricane Andrew	United States, Bahamas	27 billion	46 billion
July - August 1998	Flooding	China	31 billion	45 billion

Exhibit 72: Top 10 Costliest Global Insured Loss Events (1950-2016)

Date	Event	Location	Insured Loss[1] Actual (USD)	Insured Loss[2] (2016 USD)
August 2005	Hurricane Katrina	United States	67 billion[3]	82 billion
March 11, 2011	EQ/Tsunami	Japan	35 billion	38 billion
October 2012	Hurricane Sandy	US, Caribbean, Bahamas, Canada	30 billion	31 billion
August 1992	Hurricane Andrew	US, Bahamas	16 billion	27 billion
January 17, 1994	Earthquake	United States	15 billion	25 billion
September 2008	Hurricane Ike	United States	15 billion	17 billion
June - Dec. 2011	Flooding	Thailand	16 billion	16 billion
Yearlong 2012	Drought	United States	15 billion	16 billion
October 2005	Hurricane Wilma	United States	12 billion	15 billion
February 22, 2011	Earthquake	New Zealand	14 billion	15 billion

[1] Insured loss include those sustained from direct damages, plus additional directly attributable event costs
[2] Adjusted using US Consumer Price Index (CPI)
[3] Estimate as provided by the National Hurricane Center

Exhibit 73: Top 10 Global Human Fatality Events (1950-2016)

Date	Event	Location	Economic Loss[1] Actual (USD)	Insured Loss[2] (2016 USD)	Fatalities
November 1970	Tropical Cyclone	Bangladesh	90 million	N/A	300,000
July 27, 1976	Earthquake	China	5.6 billion	N/A	242,769
Dec. 26, 2004	EQ/Tsunami	Indonesia	14.0 billion	3.0 billion	227,898
January 12, 2010	Earthquake	Haiti	8.0 billion	100 million	222,570
April 1991	Cyclone Gorky	Bangladesh	2.0 billion	100 million	138,866
May 2008	Cyclone Nargis	Myanmar	10.0 billion	N/A	138,366
August 1971	Flooding	Vietnam	N/A	N/A	100,000
May 12, 2008	Earthquake	China	85.0 billion	366 million	88,000
October 8, 2005	Earthquake	Pakistan	5.2 billion	50 million	88,000
Summer 2003	Drought/Heatwave	Europe	13.5 billion	1.1 billion	70,000

Exhibit 74: Top 10 Costliest United States Natural Disaster Events (1950-2016)

Date	Event	Location	Economic Loss[1] Actual (USD)	Economic Loss[2] (2016 USD)
August 2005	Hurricane Katrina	Southeast	125 billion	152 billion
October 2012	Hurricane Sandy	Eastern U.S.	72 billion	74 billion
January 17, 1994	Earthquake	California	44 billion	72 billion
August 1992	Hurricane Andrew	Southeast	27 billion	46 billion
Summer 1988	Drought	Nationwide	20 billion	41 billion
September 2008	Hurricane Ike	Texas, Midwest, Northeast	35 billion	38 billion
Summer 1993	Flooding	Mississippi Valley	21 billion	35 billion
Yearlong 2012	Drought	Nationwide	30 billion	32 billion
Yearlong 1980	Drought	Nationwide	10 billion	31 billion
October 2005	Hurricane Wilma	Florida	25 billion	29 billion

[1] Economic loss include those sustained from direct damages, plus additional directly attributable event costs
[2] Adjusted using US Consumer Price Index (CPI)

Appendix C: Tropical Cyclone Frequency Comparisons

The following shows how the El Niño/Southern Oscillation (ENSO) affects global tropical cyclone frequencies and also how the Atlantic Multidecadal Oscillation (AMO) affects activity in the Atlantic Ocean 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 75: Atlantic Basin Hurricane Frequency by ENSO Phase

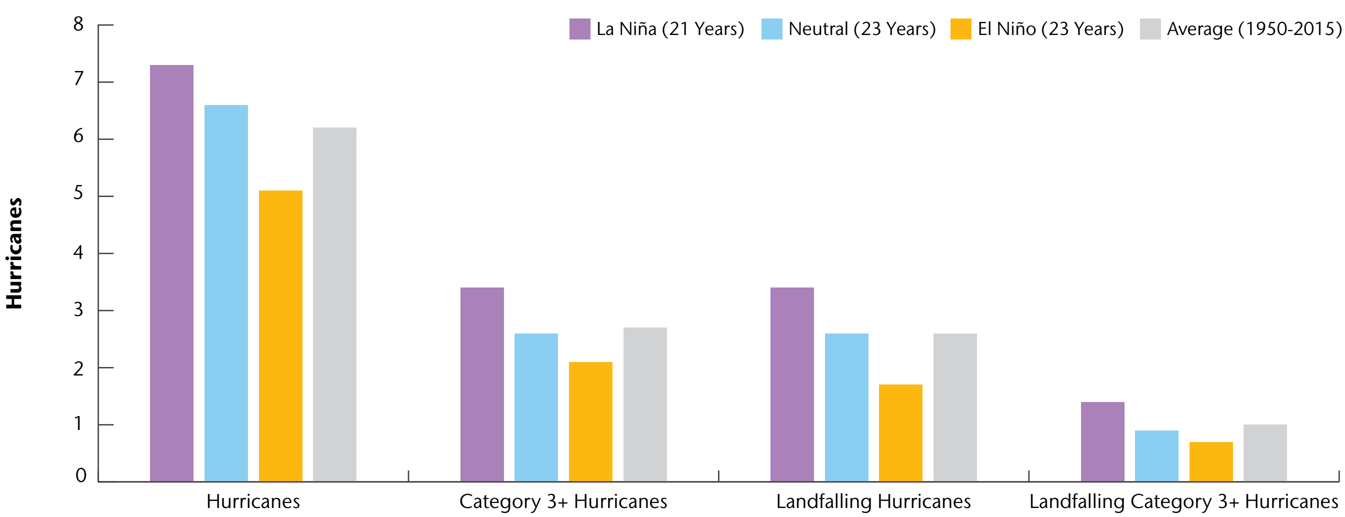


Exhibit 76: Atlantic Basin Hurricane Frequency by AMO Phase

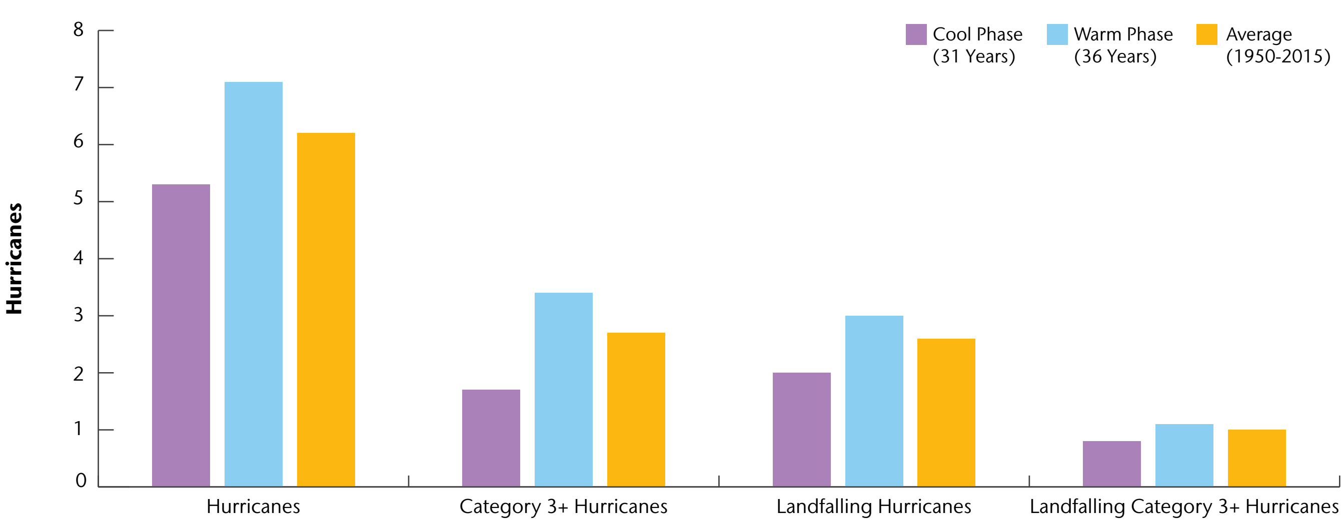


Exhibit 77: United States Hurricane Landfall Frequency by ENSO Phase

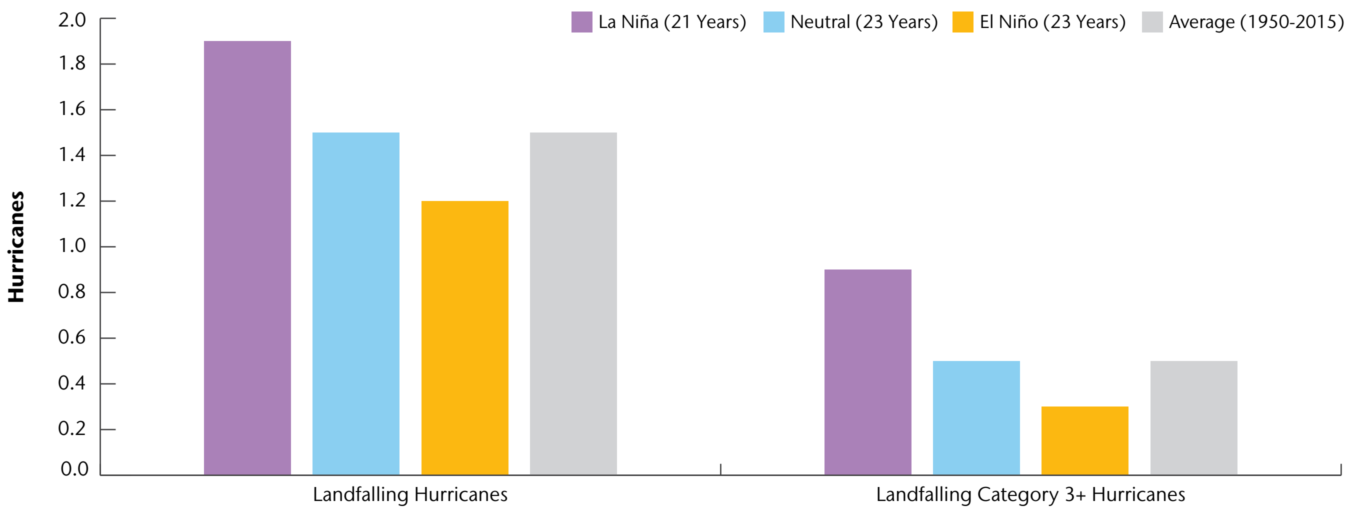
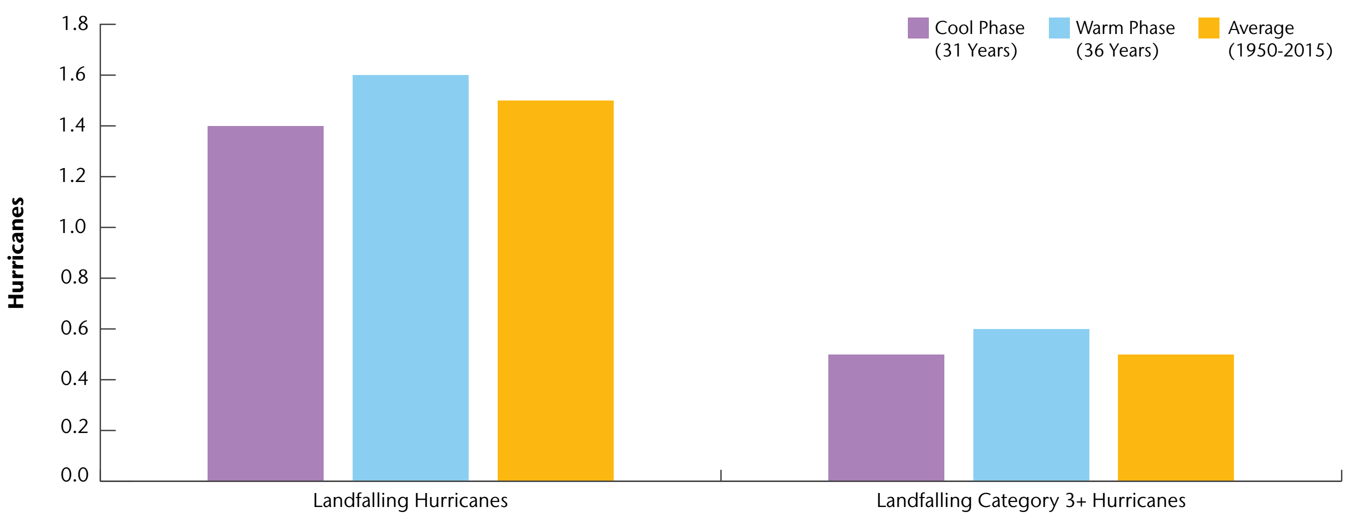
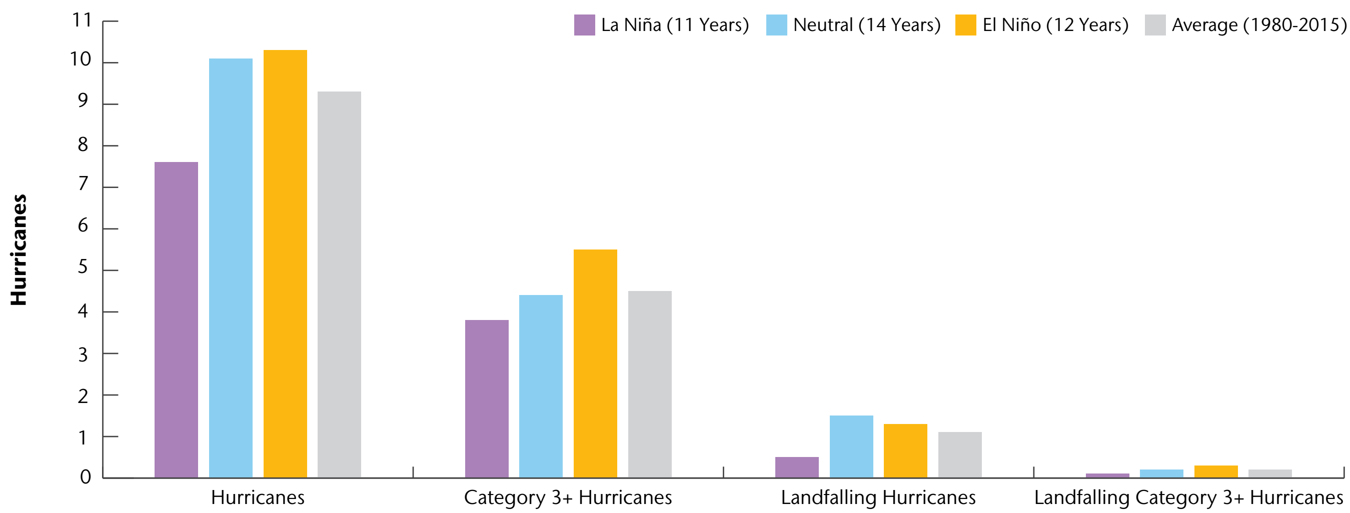


Exhibit 78: United States Hurricane Landfall Frequency by AMO Phase



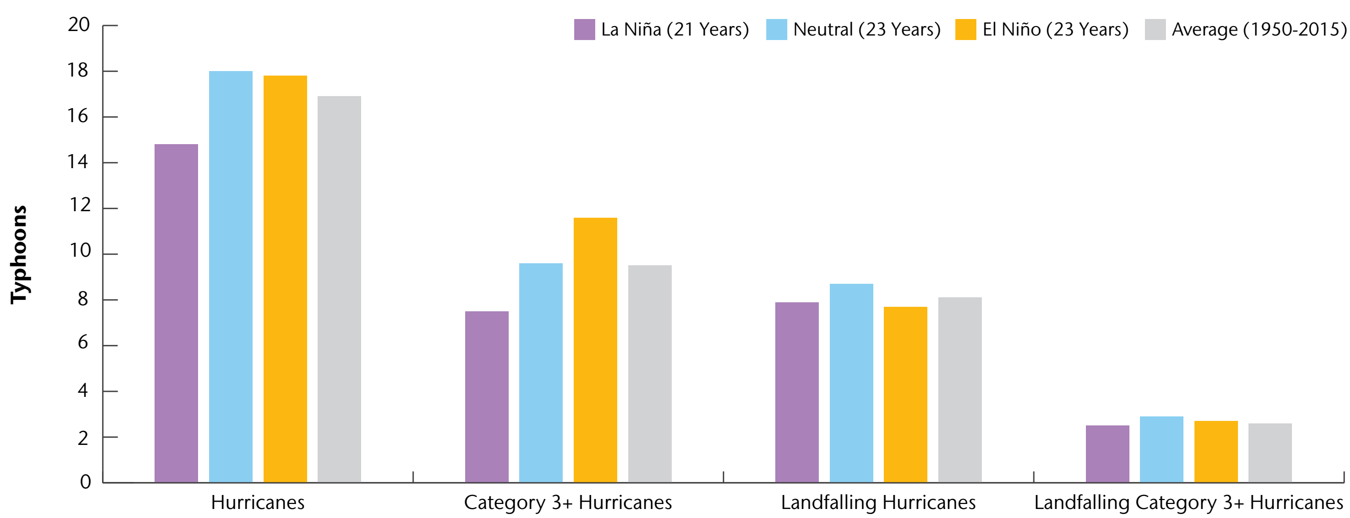
Eastern Pacific Ocean Basin

Exhibit 79: Eastern and Central Pacific Basin Hurricane Frequency by ENSO Phase



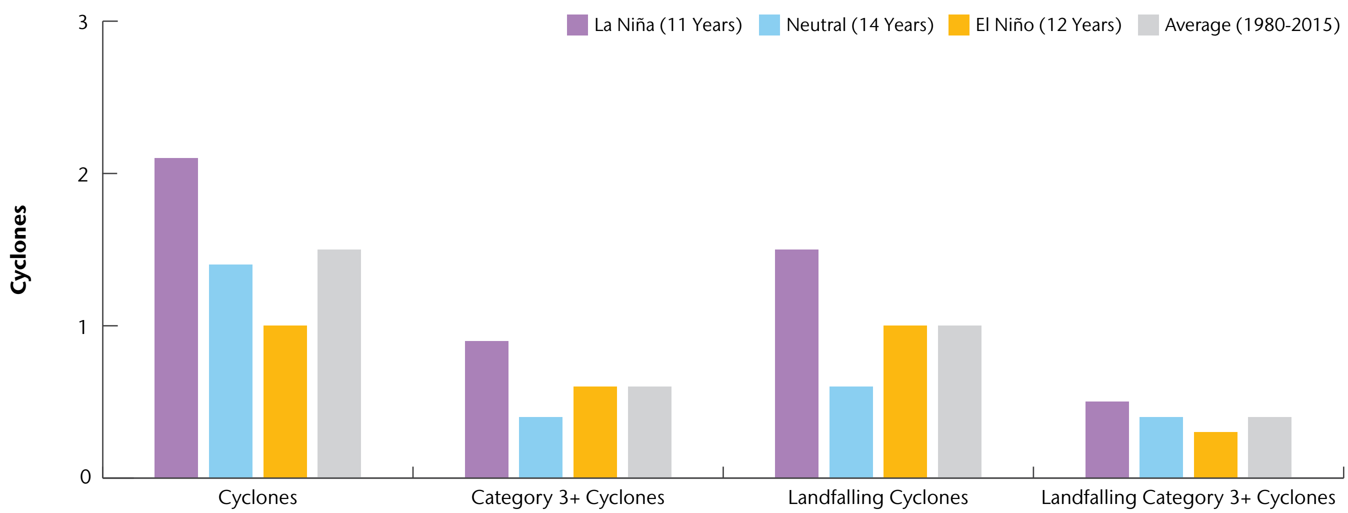
Western Pacific Ocean Basin

Exhibit 80: Western Pacific Basin Typhoon Frequency by ENSO Phase



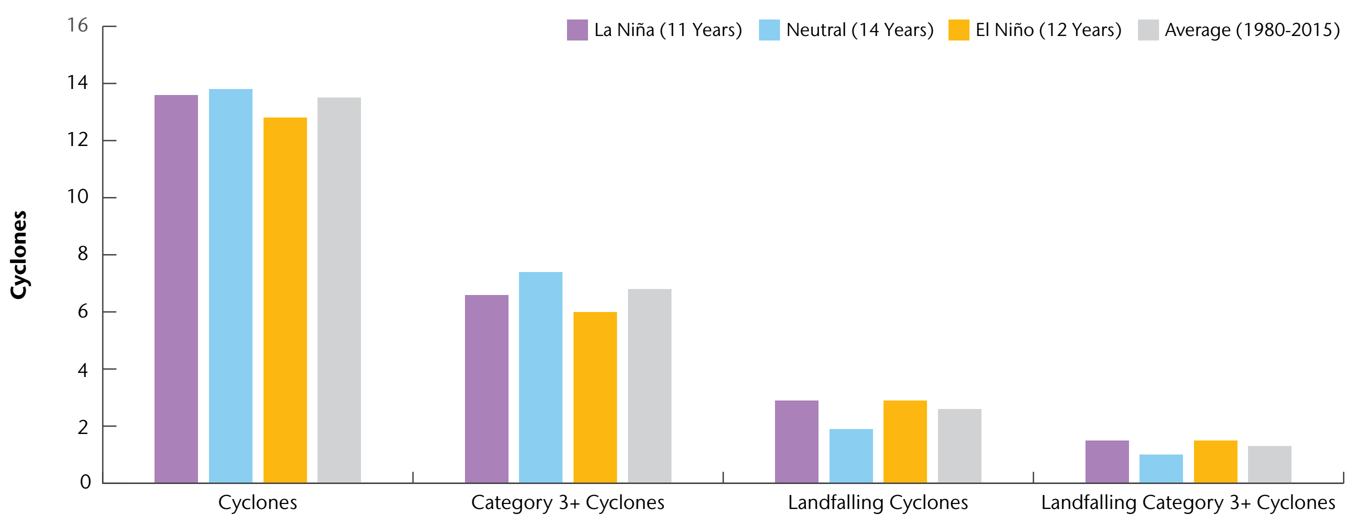
North Indian Ocean Basin

Exhibit 81: North Indian Basin Cyclone Frequency by ENSO Phase



Southern Hemisphere

Exhibit 82: Southern Hemisphere Cyclone Frequency by ENSO Phase



Appendix D: Tropical Cyclone Landfall Data by Basin

The following shows a breakdown of historical tropical cyclone landfall data 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.

Exhibit 83: Atlantic Ocean Basin Hurricane Landfalls

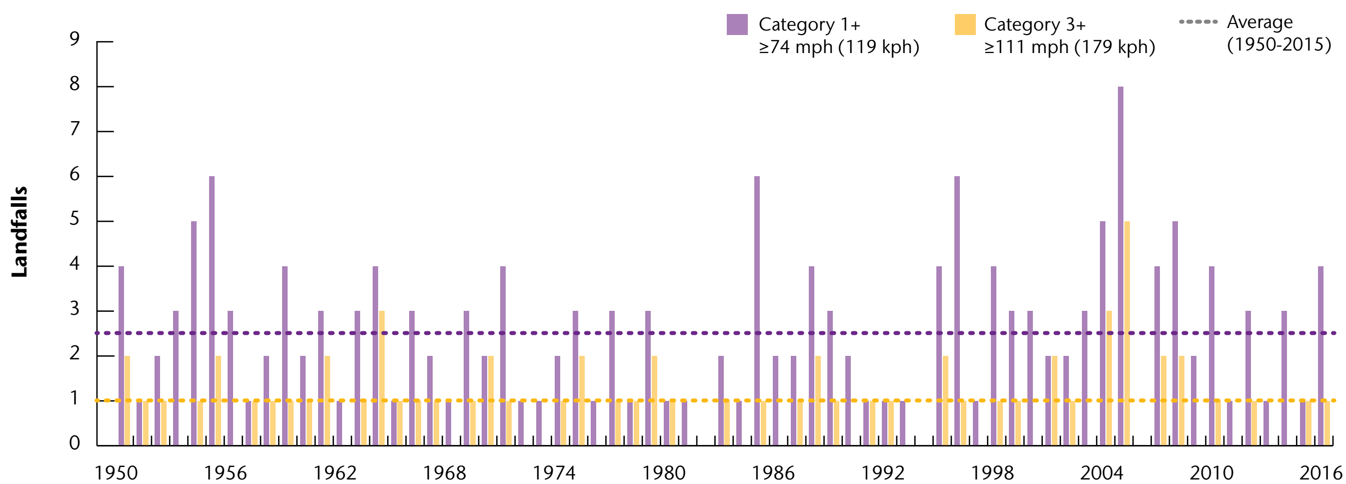


Exhibit 84: United States Hurricane Landfalls

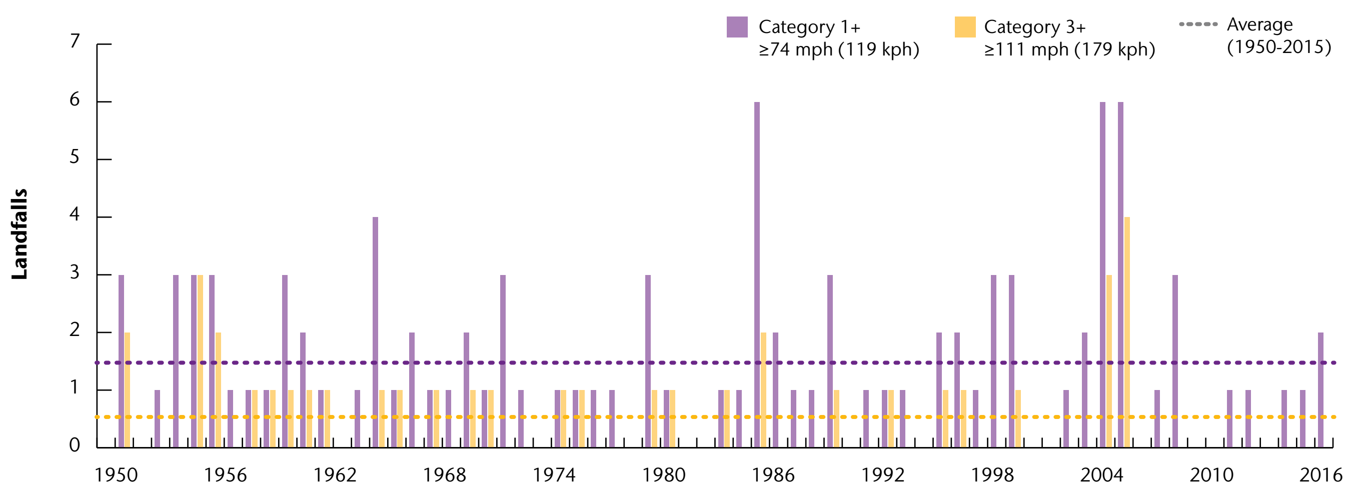


Exhibit 85: Eastern Pacific Ocean Basin Hurricane Landfalls

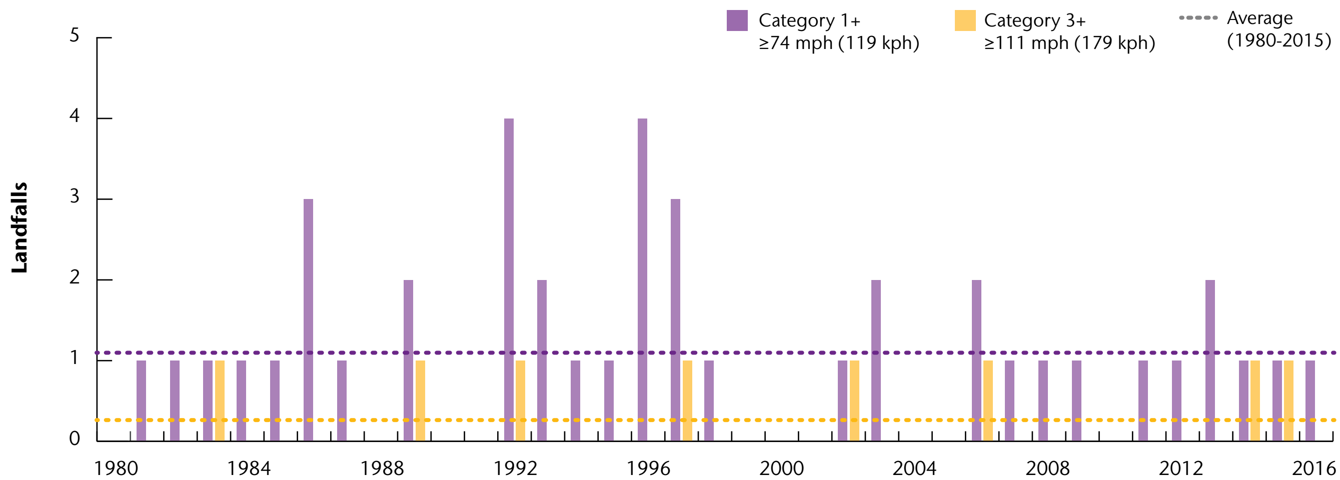


Exhibit 86: Western Pacific Ocean Basin Typhoon Landfalls

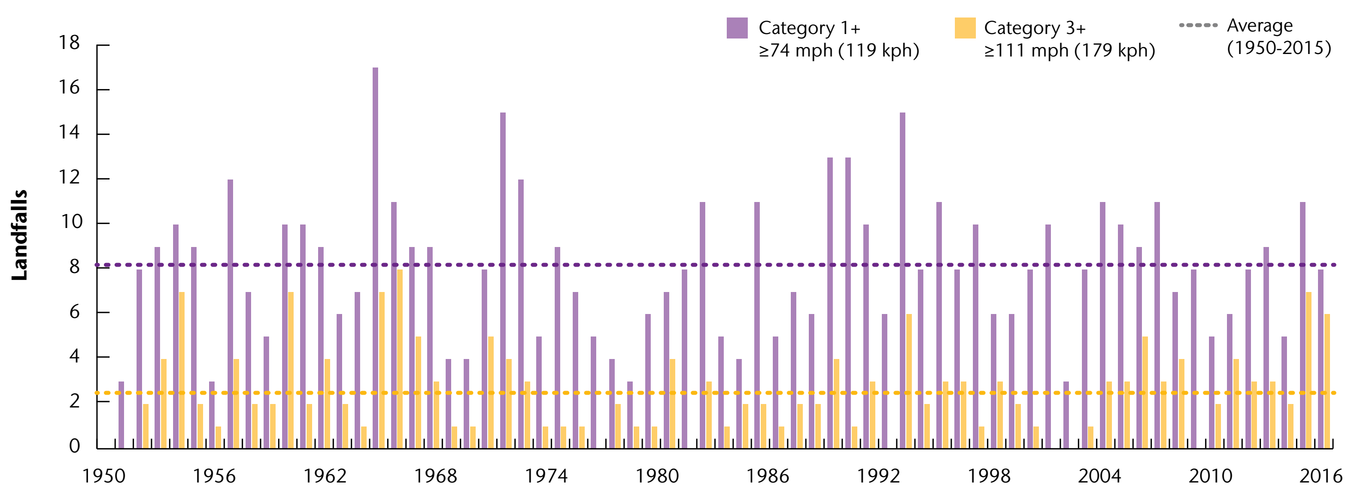


Exhibit 87: North Indian Ocean Basin Cyclone Landfalls

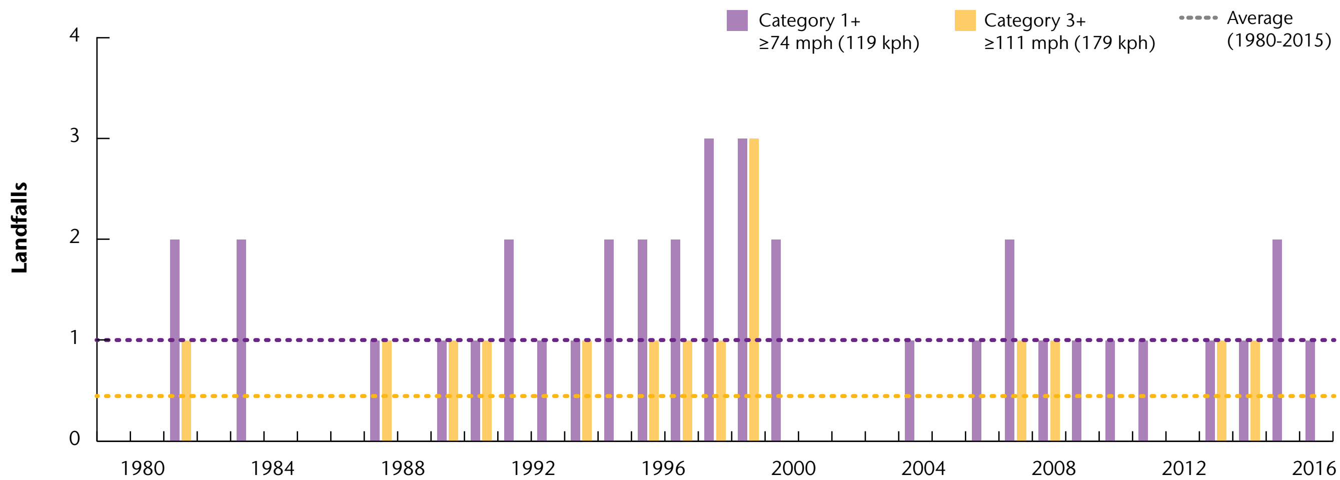
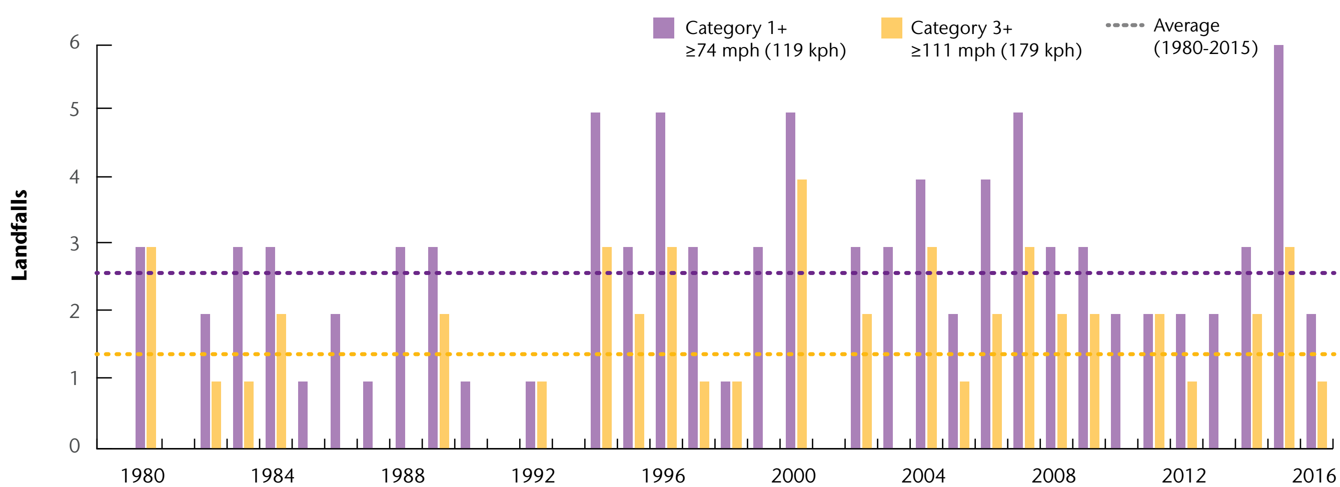


Exhibit 88: Southern Hemisphere Cyclone Landfalls



Appendix E: United States Tornado Frequency Data

The following is a breakdown of U.S. tornado frequency since 1950 as provided by data from the Storm Prediction Center. Also included is the total number of tornado-related fatalities. Please note that advances in technology, particularly the implementation of Doppler radar, have resulted in more precise tornado detection rates – particularly with F0/EF0 tornadoes – since the early 1990s. Data sets prior to this time are typically considered incomplete, especially in regards to the number of tornadoes below F3/EF3 strength. When trying to determine potential tornado frequency trends, a more accurate method is to use tornadoes with F1/EF1 intensity or greater given the larger confidence level in data collection of such twisters (as opposed to F0/EF0).

Exhibit 89: U.S. Tornadoes

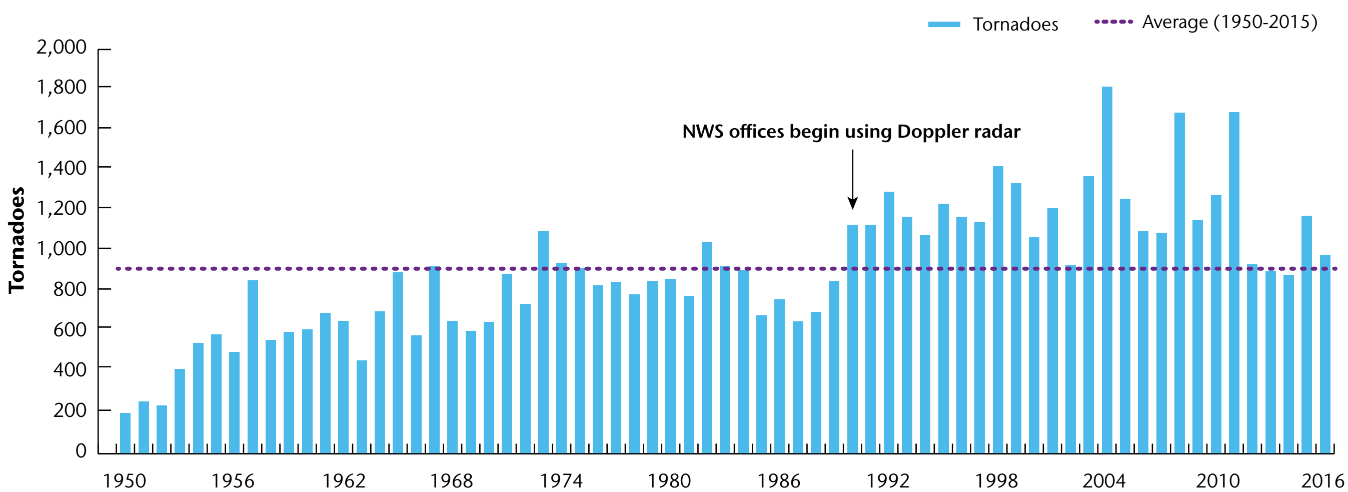
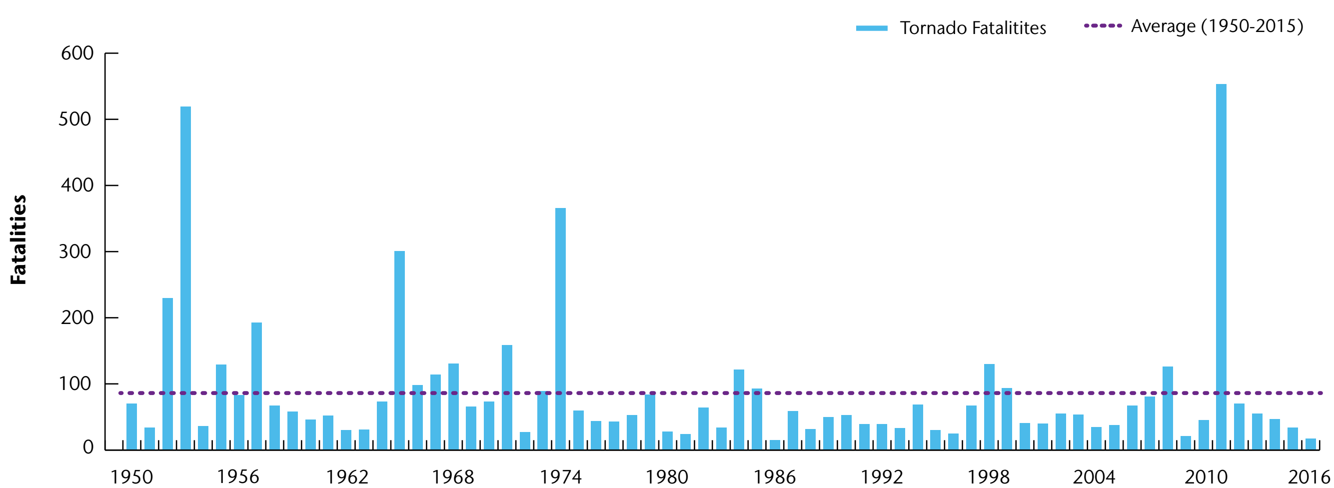
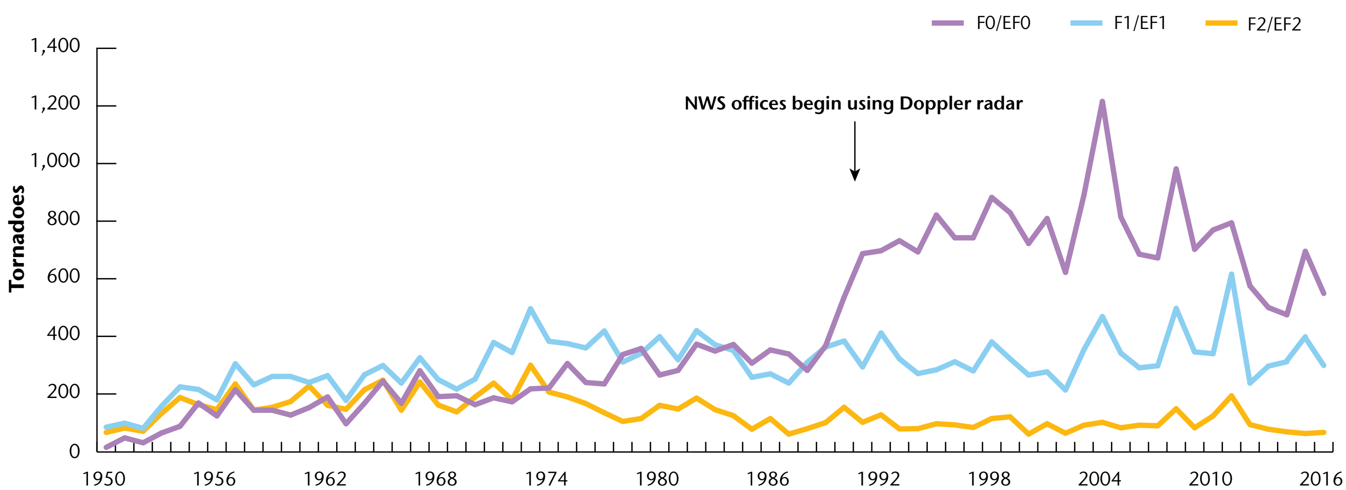


Exhibit 90: U.S. Tornado Fatalities



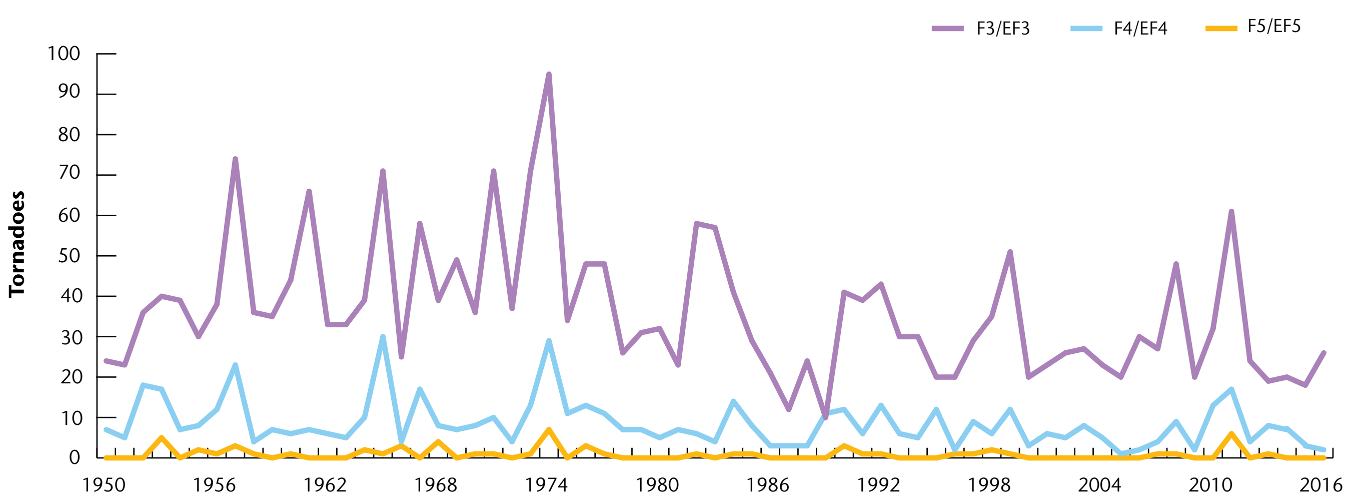
Since 1950, the overall trend of tornadoes rated at F1/EF1 and above has remained nearly flat with a minimal 1.3% annual growth. Dependable data since the advent of the Doppler-era in 1990 shows a similar flat annual growth trend at just 0.2%. When breaking down data to just the last 10 years, there has been a slight downward trend of 1.6%.

Exhibit 91: U.S. Tornadoes by Rating (F1/EF1+, F2/EF2+)



Since 1950, the overall trend of higher-end tornadoes rated at F3/EF3 and above has remained nearly flat and shows a slight annual decrease of 0.8%. A comparable 1.2% annual decrease is also found when looking at dependable data since the advent of Doppler radar in 1990. When breaking down data to just the last 10 years, there has been a similar nearly flat growth at 0.5%.

Exhibit 92: U.S. Tornadoes by Rating (F3/EF3+, F4/EF4+)



Given the level of attention that tornadic activity causes in the United States, there has been increased interest in attempting to determine whether certain atmospheric phases can be used to correlate seasonal patterns. The following exhibits analyze U.S. tornado frequencies in relation to ENSO phases. Based on data from the Storm Prediction Center since 1950, it appears that tornadic activity is slightly elevated during La Niña phases, especially higher-end tornadoes with ratings at or above F3/EF3 strength. However, the number of tornadoes during ENSO-neutral conditions is near the long-term average, and the totals from El Niño phases are slightly below average.

Exhibit 93: U.S. Tornado Frequency by ENSO Phase (Total, F1/EF1+, F2/EF2+)

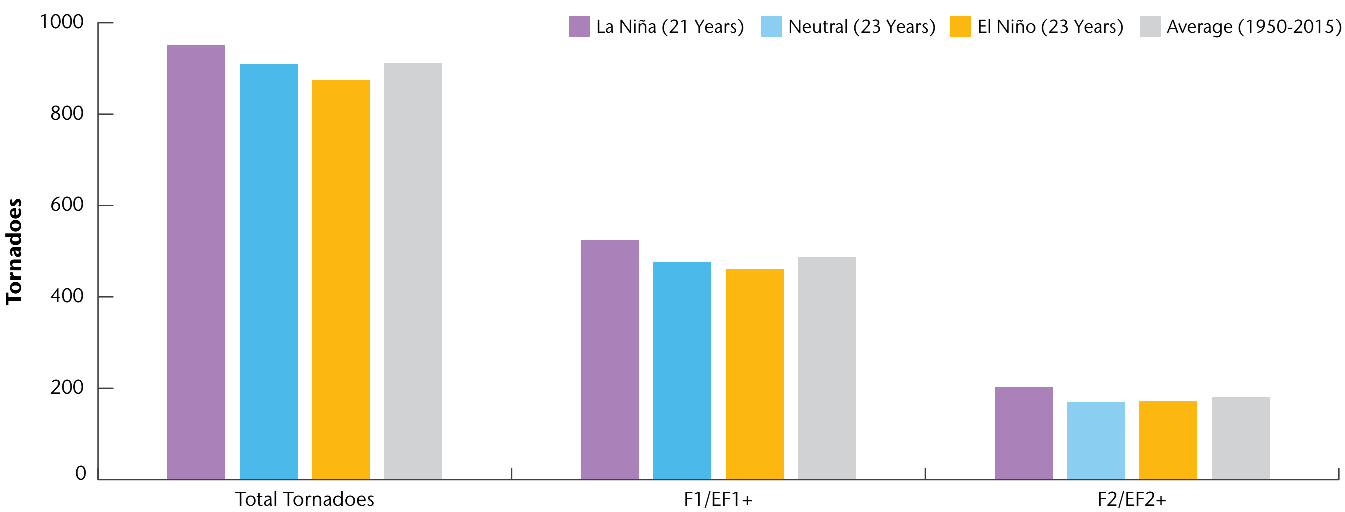
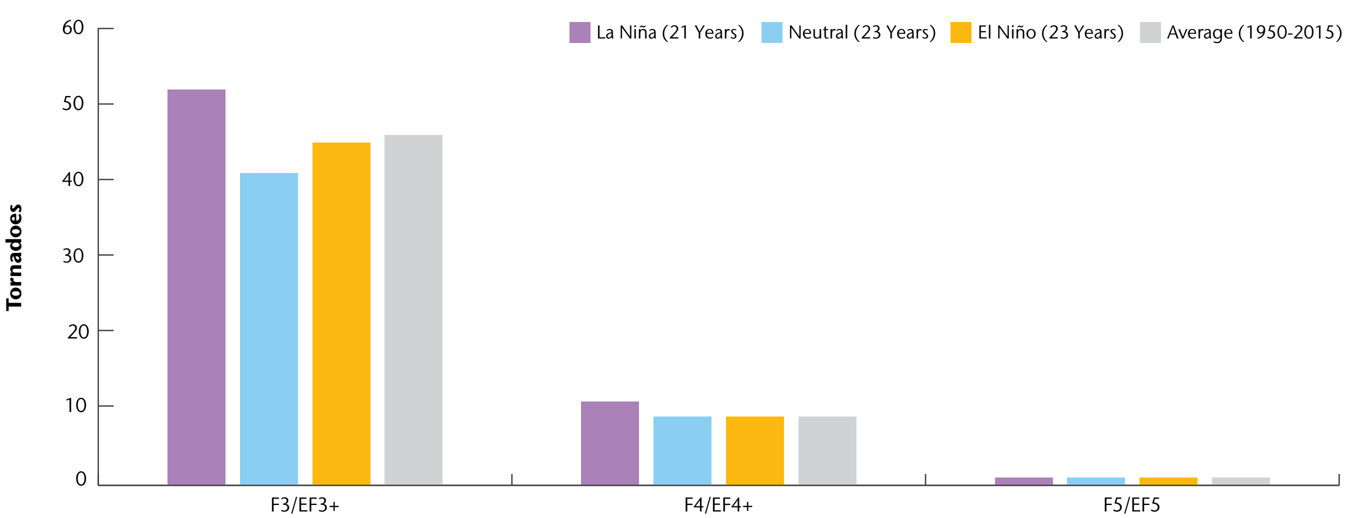


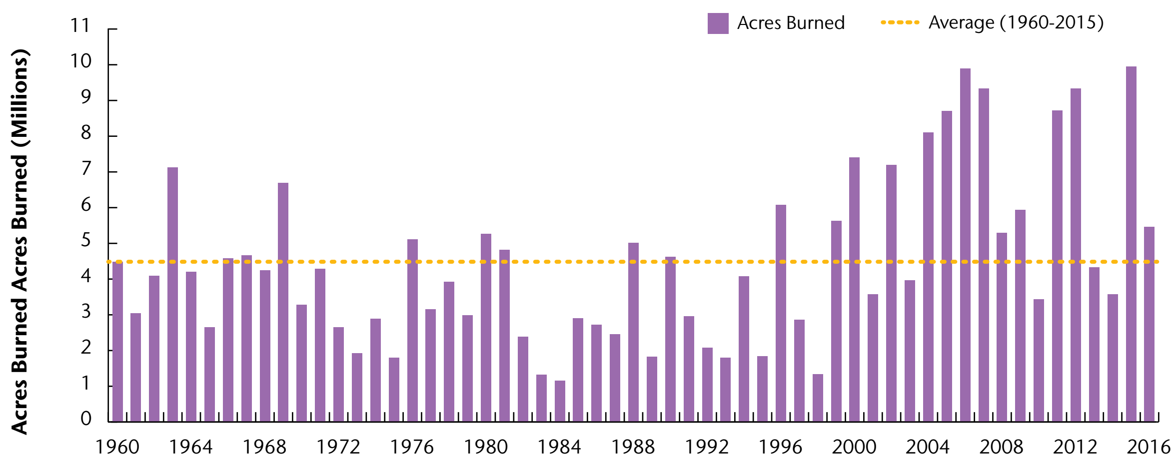
Exhibit 94: U.S. Tornado Frequency by ENSO Phase (F3/EF3+, F4/EF4+, F5/EF5)



Appendix F: United States Wildfire Data

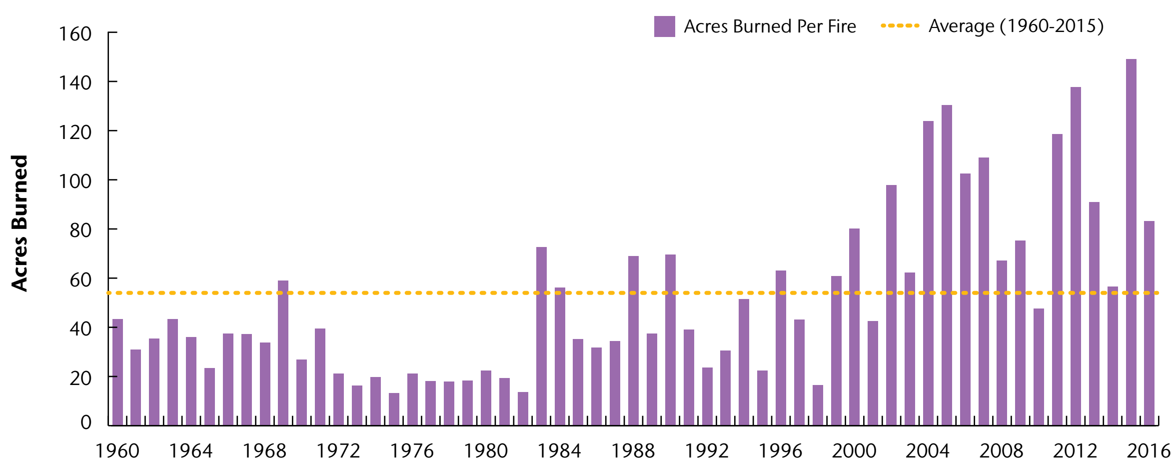
The following provides a breakdown of United States wildfire activity since 1960 as provided by data from the National Interagency Fire Center (NIFC) and the National Interagency Coordination Center (NICC). Historically, the West and Alaska frequently endure the largest amount of burn acreage with the Southwest also seeing regular elevated burn totals. Please note that the NICC maintained wildfire records from 1960 to 1982 before the NIFC began their current method of data compilation from states and other agencies in 1983.

Exhibit 95: U.S. Wildfire Acres Burned



Source: National Interagency Fire Center

Exhibit 96: U.S. Wildfire Acres Burned Per Fire



Source: National Interagency Fire Center

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.

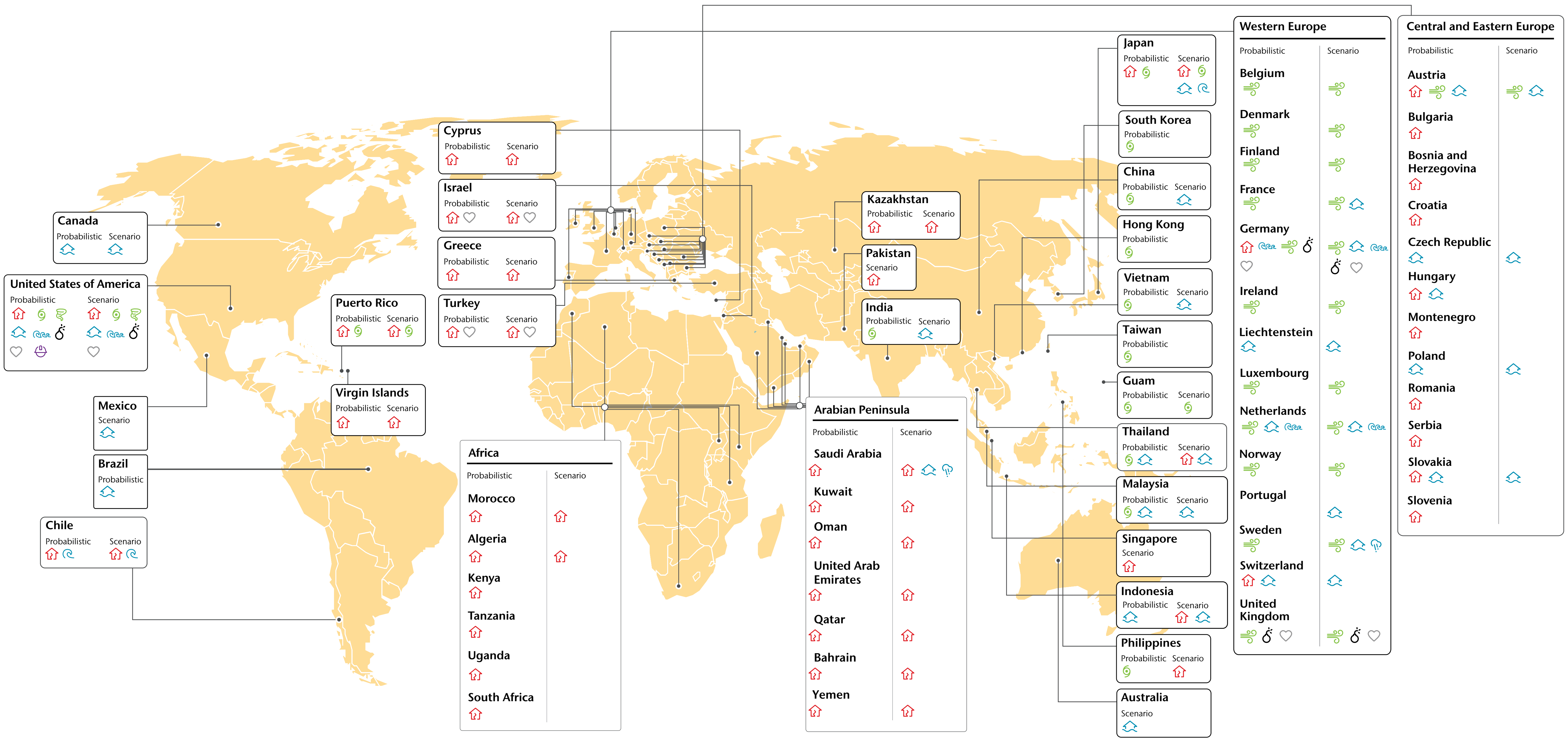
Structures defined as any building — including barns, outbuildings, mobile homes, single or multiple family dwellings, and commercial facilities — that is damaged or destroyed by winds, earthquakes, hail, flood, tornadoes, hurricanes or any other natural-occurring phenomenon. Claims defined as the number 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. Specific events may include modeled estimates determined from utilizing Impact Forecasting's suite of catastrophe model products.

All exhibits are sourced as Aon Benfield Impact Forecasting unless otherwise noted.

This report use publicly available data from the internet and other sources. Impact Forecasting® summarizes this publicly available information for the convenience of those individuals who have contacted Impact Forecasting® and expressed an interest in natural catastrophes of various types. To find out more about Impact Forecasting or to sign up for the Cat Reports, visit Impact Forecasting's webpage at **www.impactforecasting.com.**

Impact Forecasting Model Coverage Map



Map Icons

*tornado / hail / severe winds / thunderstorm

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.**

About Aon Benfield

Aon Benfield, a division of Aon plc (NYSE: AON), is the world's leading reinsurance intermediary and full-service capital advisor. We empower our clients to better understand, manage and transfer risk through innovative solutions and personalized access to all forms of global reinsurance capital across treaty, facultative and capital markets. As a trusted advocate, we deliver local reach to the world's markets, an unparalleled investment in innovative analytics, including catastrophe management, actuarial and rating agency advisory. Through our professionals' expertise and experience, we advise clients in making optimal capital choices that will empower results and improve operational effectiveness for their business. With more than 80 offices in 50 countries, our worldwide client base has access to the broadest portfolio of integrated capital solutions and services. To learn how Aon Benfield helps empower results, please visit **aonbenfield.com.**

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