Weather, Climate & Catastrophe Insight

2017 Annual Report
Table of Contents

Executive Summary: 2017's Natural Disaster Events ............... 1

2017 Natural Disaster Events & Loss Trends ......................... 2
  Global Economic Losses ........................................... 2
  Global Insured Losses ............................................. 6
  Global Fatalities .................................................. 11
  Natural Disasters Defined & Total Events .......................... 12

2017 Natural Peril Review ............................................. 13
  Tropical Cyclone ................................................... 13
  Severe Weather ..................................................... 18
  Wildfire ............................................................. 20
  Earthquake .......................................................... 22
  Other Perils .......................................................... 23

2017 Climate Review .................................................... 24
  Global Temperature, ENSO ....................................... 25
  Global Carbon Dioxide .......................................... 26
  Arctic Sea Ice ....................................................... 27

2017 Global Catastrophe Review ................................... 30
  United States ....................................................... 30
  Americas (Non-U.S.) .............................................. 35
  EMEA (Europe, Middle East, and Africa) .................... 41
  APAC (Asia and Oceania) ....................................... 47

About Impact Forecasting ............................................. 52

About Aon Benfield .................................................... 52

Contacts .............................................................. 53
Executive Summary

2017: Costliest year on record for weather disasters

Insurance industry in position to handle high volume of claims payouts

- **USD 353 billion**
  - Economic cost of natural disasters in 2017; second-costliest year on record

- **USD 134 billion**
  - Insured cost of natural disasters in 2017; second-costliest year on record

- **USD 344 billion**
  - Costliest year ever recorded for weather disasters

- **USD 132 billion**
  - Costliest year for insurers for weather disasters

- **+93%**
  - Percentage of how much higher 2017 economic losses vs. 2000-2016 average

- **+163%**
  - Percentage of how much higher 2017 insured losses vs. 2000-2016 average

- **USD 220 billion**
  - Economic cost of hurricanes Harvey, Irma, and Maria

- **USD 80 billion**
  - Insured cost of hurricanes Harvey, Irma, and Maria

- **62%**
  - Percentage of 2017 global economic damage from Harvey, Irma, and Maria

- **60%**
  - Percentage of 2017 global insurance payouts from Harvey, Irma, and Maria

- **USD 600 billion**
  - Amount of available capital by global reinsurers at the end of Q3 2017; industry well suited to handle the volume of claims payouts in 2017.

- **31 billion-dollar events**
  - 16 in the United States

- **14 billion-dollar insured events**
  - 11 in the United States

- **63%**
  - Of insured catastrophe losses occurred in the continental United States

- **62%**
  - Of catastrophe losses occurred in the continental United States

- **USD 24 billion**
  - Second-costliest year on record for insurers with the severe weather peril

- **USD 14 billion**
  - Costliest year on record for insurers with the wildfire peril

- **330**
  - Individual events

- **1,141+**
  - Highest casualty disaster of 2017 (Mudslide in Sierra Leone)

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
## Global Economic Losses

### Exhibit 1: Top 10 Global Economic Loss Events

<table>
<thead>
<tr>
<th>Date(s)</th>
<th>Event</th>
<th>Location</th>
<th>Deaths</th>
<th>Economic Loss (USD)</th>
<th>Insured Loss (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 25 – Sept. 2</td>
<td>Hurricane Harvey</td>
<td>United States</td>
<td>90</td>
<td>~100 billion</td>
<td>~30 billion</td>
</tr>
<tr>
<td>September 18-22</td>
<td>Hurricane Maria</td>
<td>Caribbean Islands</td>
<td>Hundreds+</td>
<td>~65 billion</td>
<td>~27 billion</td>
</tr>
<tr>
<td>September 4-12</td>
<td>Hurricane Irma</td>
<td>U.S., Caribbean Islands</td>
<td>134</td>
<td>~55 billion</td>
<td>~23 billion</td>
</tr>
<tr>
<td>October</td>
<td>Wildfires</td>
<td>United States</td>
<td>43</td>
<td>13 billion</td>
<td>11 billion</td>
</tr>
<tr>
<td>Summer</td>
<td>Flooding</td>
<td>China</td>
<td>116</td>
<td>7.5 billion</td>
<td>300 million</td>
</tr>
<tr>
<td>Summer &amp; Autumn</td>
<td>Drought</td>
<td>Southern Europe</td>
<td>N/A</td>
<td>6.6 billion</td>
<td>700 million</td>
</tr>
<tr>
<td>September 19</td>
<td>Earthquake</td>
<td>Mexico</td>
<td>370</td>
<td>4.5 billion</td>
<td>1 billion</td>
</tr>
<tr>
<td>July</td>
<td>Flooding</td>
<td>China</td>
<td>37</td>
<td>4.5 billion</td>
<td>125 million</td>
</tr>
<tr>
<td>August 23-25</td>
<td>Typhoon Hato</td>
<td>China</td>
<td>22</td>
<td>3.5 billion</td>
<td>250 million</td>
</tr>
<tr>
<td>May 8-11</td>
<td>Severe Weather</td>
<td>United States</td>
<td>0</td>
<td>3.4 billion</td>
<td>2.6 billion</td>
</tr>
<tr>
<td></td>
<td>All Other Events</td>
<td></td>
<td></td>
<td>90 billion</td>
<td>38 billion</td>
</tr>
</tbody>
</table>

**Totals**: 353 billion\(^1\) 134 billion\(^1,2\)

### Exhibit 2: Significant 2017 Economic Loss Events\(^3\)

- Hurricane Harvey: 100 billion
- California Wildfires: 13 billion
- Hurricane Irma: 55 billion
- Hurricane Maria: 65 billion

\(^1\) Subject to change as loss estimates are further developed
\(^2\) Includes losses sustained by private insurers and government-sponsored programs
\(^3\) Based on events that incurred economic loss greater than USD250 million. Position of an event is determined by the most affected administrative unit or epicenter
Economic losses arising from natural disasters in 2017 were among the highest ever recorded on a nominal, inflation-adjusted, and normalized basis. The USD353 billion total was just the second year on record to ever surpass USD300 billion on an inflation-adjusted basis, joining 2011 with losses of USD486 billion. In terms of economic losses resulting solely from weather disasters, 2017 became the costliest year ever recorded at USD344 billion. This was higher than the USD294 billion incurred in 2005.

The predominant driver of damage in 2017 resulted from one of the costliest Atlantic hurricane seasons on record following the landfalls of Hurricanes Harvey, Irma, and Maria that left extensive damage across parts of the United States and the Caribbean Islands. Those three storms alone caused an estimated USD220 billion in damage and represented 62 percent of 2017’s annual economic loss.

Other significant events during the year included the most destructive wildfire outbreak ever recorded in the state of California in the United States. The October outbreak caused nearly USD13 billion in economic damage across Northern California’s Napa Valley region and was followed by another billion-dollar wildfire outbreak in Southern California in December. Elsewhere, substantial summer flooding caused more than USD12 billion in damage across China, the majority of which occurred throughout the Yangtze River basin. Southern Europe endured an extended drought during the summer and autumn months that caused USD6.6 billion in damage across parts of Spain, Italy, and Portugal. In Mexico, two powerful earthquakes struck during September that led to nearly USD6 billion in combined economic loss. This included major damage across the Mexico City metro region on the 32nd anniversary of its historic 1985 tremor.

Total economic losses were 93 percent above the 2000 to 2016 average of USD183 billion on an inflation-adjusted basis. Damage losses were an even more significant 156 percent higher than the median of USD138 billion. Economic losses from all natural disasters have annually trended upward by 4.0 percent above the rate of inflation since 1980 and an even more robust 5.9 percent since 2000. Weather-only damage has annually trended upward by 4.2 percent above the rate of inflation since 1980 and upward by 5.4 percent since 2000.

Exhibit 3: Global Economic Losses

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*Nominal: Damage cost at the time of occurrence*

*Inflation-Adjusted: Nominal loss adjusted to today’s dollars using the U.S. Consumer Price Index*

*Normalized: Hypothetical damage cost if a historical event occurred today with current wealth, population and exposure*
For the first time since 2012, the tropical cyclone peril was the costliest of the year at USD232 billion. It represented 66 percent of the global tally and was led by landfalling hurricanes in the Atlantic Ocean Basin. Other perils that registered aggregated damage costs in excess of USD25 billion were severe weather (USD36 billion) and flooding (USD30 billion). It’s worth noting that the severe weather peril had its costliest year since 2011, flooding had its lowest year since 2009, and the wildfire peril had its costliest year in decades.

Exhibit 4: Global Economic Losses by Peril

![Exhibit 4: Global Economic Losses by Peril](image)

Source: Aon Benfield

There have only been six individual quarters on record that have caused more than USD100 billion in inflation-adjusted economic damage, five of which have occurred since the turn of the 21st century. The third quarter of 2017 was the second-costliest quarter ever registered at USD261 billion due to catastrophic damage caused by a trio of major hurricanes and flooding across Asia. It was far behind first quarter 2011, which was dominated by the Tohoku Earthquake & Tsunami and other seismic and hydrologic events in Oceania.

Exhibit 5: Costliest Quarters by Economic Loss

![Exhibit 5: Costliest Quarters by Economic Loss](image)

Source: Aon Benfield
There were 31 individual billion-dollar natural disaster events in 2017, which is above the average of 27 individual events dating to 2000, but lower than the 36 individual events in 2016. The United States led with 16 individual events (just behind the record 17 in 2011), while APAC was second with 8, the Americas was third with 5, and EMEA was fourth with 3.

In terms of weather-only billion-dollar events in 2017, there were 29 individual events, which is above the average of 25 dating back to 2000 and 2 individual events below the 31 registered in 2016. The United States led with 16 individual events (just shy of the 17 recorded in 2011), APAC was second with 8, while the Americas and EMEA both experienced 3.

(Please note that Hurricane Irma was a billion-dollar event for the United States mainland and the Caribbean Islands. For this analysis, it was counted for both regions, but classified as a singular event for the final global tally.)

Exhibit 6: Global Billion-Dollar Economic Loss Events

Source: Aon Benfield
Note: Exhibit 6 includes events that reached the billion-dollar (USD) threshold after being adjusted for inflation based on the 2017 U.S. Consumer Price Index.
Global Insured Losses

Exhibit 7: Top 10 Global Insured Loss Events

<table>
<thead>
<tr>
<th>Date(s)</th>
<th>Event</th>
<th>Location</th>
<th>Deaths</th>
<th>Economic Loss (USD)</th>
<th>Insured Loss (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 25 – Sept. 2</td>
<td>Hurricane Harvey</td>
<td>United States</td>
<td>90</td>
<td>-100 billion</td>
<td>-30 billion</td>
</tr>
<tr>
<td>September 18-22</td>
<td>Hurricane Maria</td>
<td>Caribbean Islands</td>
<td>Hundreds+</td>
<td>-65 billion</td>
<td>-27 billion</td>
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<tr>
<td>September 4-12</td>
<td>Hurricane Irma</td>
<td>U.S., Caribbean Islands</td>
<td>134</td>
<td>-55 billion</td>
<td>-23 billion</td>
</tr>
<tr>
<td>October</td>
<td>Wildfires</td>
<td>United States</td>
<td>43</td>
<td>13 billion</td>
<td>11 billion</td>
</tr>
<tr>
<td>May 8-11</td>
<td>Severe Weather</td>
<td>United States</td>
<td>0</td>
<td>3.4 billion</td>
<td>2.6 billion</td>
</tr>
<tr>
<td>December</td>
<td>Wildfires</td>
<td>United States</td>
<td>2</td>
<td>3.2 billion</td>
<td>2.2 billion</td>
</tr>
<tr>
<td>March 26-28</td>
<td>Severe Weather</td>
<td>United States</td>
<td>0</td>
<td>2.6 billion</td>
<td>2.0 billion</td>
</tr>
<tr>
<td>Spring &amp; Summer</td>
<td>Drought</td>
<td>United States</td>
<td>0</td>
<td>2.5 billion</td>
<td>1.9 billion</td>
</tr>
<tr>
<td>March 6-10</td>
<td>Severe Weather</td>
<td>United States</td>
<td>0</td>
<td>2.2 billion</td>
<td>1.6 billion</td>
</tr>
<tr>
<td>June 11</td>
<td>Severe Weather</td>
<td>United States</td>
<td>0</td>
<td>2.0 billion</td>
<td>1.6 billion</td>
</tr>
</tbody>
</table>

All Other Events | 104 billion | 31 billion

Totals | 353 billion\(^4\) | 134 billion\(^4,5\)

Exhibit 8: Significant 2017 Insured Loss Events\(^6\)

\(^4\) Subject to change as loss estimates are further developed
\(^5\) Includes losses sustained by private insurers and government-sponsored programs
\(^6\) Based on events that incurred insured loss greater than USD100 million. Position of an event is determined by the most affected administrative unit or epicenter
Insured losses from natural disasters in 2017 were among the costliest ever incurred by the insurance industry. This includes payouts by private insurers and public entities such as the National Flood Insurance Program or the Risk Management Agency’s Crop Insurance Program in the United States. The USD134 billion in payouts were the second-highest on the inflation-adjusted record, just behind 2011 (USD137 billion) and slightly above 2005 (USD129 billion). The year marked just the third time that insured losses from natural catastrophes had surpassed USD100 billion on a nominal or inflation-adjusted basis. In terms of insured losses resulting solely from weather disasters, 2017 slightly surpassed 2005 as the most expensive year ever recorded at USD132 billion for the industry.

It is worth noting that the insurance industry was well positioned to handle the cost of the 2017 disasters. Global reinsurer capital was a record USD600 billion at the end of third quarter 2017. This is a broad measure to detail how much capital insurers had available to trade risk, and also ensured that both insurers and reinsurers were capable to withstand the extensive losses during the year. Additionally, the industry was in a much better position to handle a high catastrophe loss year in 2017 as opposed to 2005 and 2011. For more details, please see Aon Benfield’s Reinsurance Market Outlook.

The vast majority of insurance payments came from three hurricane events: Harvey, Irma, and Maria. Those three storms cost the industry an estimated USD80 billion alone, which was equivalent to 60 percent of all losses from 2017. Given these tropical cyclone events, the severe weather (convective storm) peril was not the costliest peril for insurers for the first time since 2012.

Outside of Harvey, Irma, and Maria—which each required insurance payouts in excess of USD20 billion—the most significant event was the outbreak of October wildfires in Northern California. Total fires payouts from that event cost the industry at least USD11 billion. Nine of the ten costliest insured loss events in 2017 impacted the continental United States, including four that were severe weather-related. The costliest severe weather outbreak was registered from May 8-11 that included the most expensive hail event on record in the greater Denver, Colorado metro region. Beyond the U.S. and the Caribbean, the most notable event was the September 19 Mexico earthquake and Cyclone Debbie in Australia. At USD1.3 billion, Debbie became the second-costliest event on record for the local industry.

Total insured losses were a remarkable 163 percent above the 2000 to 2016 average (USD51 billion) on an inflation-adjusted basis. Payouts were an even more significant 212 percent higher than the median at USD43 billion. Insured losses from all natural disasters have annually trended upward by 7.1 percent above inflation since 1980 and 5.5 percent since 2000. Weather-only damage has annually trended upward by 7.0 percent above the rate of inflation since 1980 and upward by 4.7 percent since 2000.

Exhibit 9: Global Insured Losses

![Graph of Global Insured Losses](source: Aon Benfield)
For the first time since 2012, the tropical cyclone peril was the costliest of the year at USD83 billion. It represented 62 percent of the
global tally. Other perils that registered aggregated damage costs in excess of USD10 billion were severe weather (USD24 billion) and
wildfire (USD14 billion). Wildfire payouts were by far the highest ever recorded in a single year. Severe weather, which references
convective storms, has been the costliest peril for insurers for 13 of the prior 18 years, which highlights its annual consistency.
Tropical cyclone is prone to more annual volatility, though can often prompt significantly higher payouts.

**Exhibit 10: Global Insured Losses by Peril**

There have only been three individual quarters on record that have caused more than USD50 billion in inflation-adjusted insurance
payouts from natural disasters and just eight that topped USD30 billion. The third quarter of 2017—at USD88 billion—was the second-
costliest quarter ever registered due to catastrophic damage caused by a trio of major hurricanes. It was second only to third quarter
2005, which was led by Hurricanes Katrina and Rita, as well as multi-billion-dollar flooding in Europe. Prior to 2000, only two quarters
passed the USD50 billion threshold: third quarter 1992 with Hurricane Andrew and first quarter 1994 with the Northridge Earthquake.

**Exhibit 11: Costliest Quarters by Insured Loss**
There were 14 individual billion-dollar natural disaster events in 2017, which is well above the average of 9 dating to 2000. It was higher than the 12 registered in 2016 and the second highest number of billion-dollar events for the insurance industry (21 in 2011). The United States led with 11 individual events, while the Americas were second with 3 and APAC had 1. For the first time since 2006, EMEA did not record any such event.

In terms of weather-only billion-dollar events, there were 13 individual billion-dollar weather events in 2017, which was well above the average of 8 dating to 2000. This was the second-greatest number of events, only behind 18 events in 2011 but higher than 10 events in 2016. The United States led with 11 events, while the Americas and APAC followed with 2 and 1 respectively. EMEA did not record any such event.

(Please note that Hurricane Irma was a billion-dollar event for the United States mainland and the Caribbean Islands. For this analysis, it was counted for both regions, but classified as a singular event for the final global tally.)

Exhibit 12: Global Billion-Dollar Insured Loss Events

![Exhibit 12: Global Billion-Dollar Insured Loss Events](source)

Source: Aon Benfield

Note: Exhibit 12 includes events that reached the billion-dollar (USD) threshold after being adjusted for inflation based on the 2017 U.S. Consumer Price Index.
The Evolution of Claims Handling Post-Harvey, Irma, & Maria

Mitch Balter  
*Executive Managing Director-Client Operations, Aon Benfield*

The Americas experienced one of its most active years in recent history due to the concoction of hurricanes, earthquakes, and wildfires. These events truly demonstrated the value of reinsurance with paid claims in an average of eight days to augment the recovery process.

As soon as an event happens, this is a critical time for the reinsurance industry when brokers, catastrophe modelers, and reinsurers come together to support insurers and in turn their customers. But the last two quarters of 2017 triggered an evolution in claims procedures and lessons to be learned for the future.

**What was unique?**
- Discussions with reinsurers about potential pre-funding of paid losses without formal proof of loss reports were a prominent theme as all parties sought to help families and businesses as quickly as possible. Almost all markets were able to pre-fund losses in the lower layers of catastrophe programs. However, it was necessary to receive periodic reports on actual and projected payments from clients to help facilitate pre-funding on higher layers.
- This was the first time that collateral markets were challenged with a notable volume of claims activity. Most funds are based on full limits and could efficiently pay claims. However, the funds based on full limits less outstanding premium, most of which were started at June and July with little time to accrue, found that collateral posted was exhausted quickly and actions were needed to obtain additional payments.
- Markets engaged with ecommerce solutions, such as ACCORD, received client information immediately and were able to respond quickly to enhance the settlement process.
- There were many variables that arose for each of the catastrophic events, including the hours clause, flood versus wind damage—with Hurricane Harvey, for example—and aggregation challenges. The California wildfires’ 168-hour clause highlighted the issues raised around when the burning started and ended and whether the individual fires counted as one event or several.
- Letter of Credit season was very late with a short window for clients to report and reinsurers to respond with their levels of liability—highlighting the importance of effective communications.
- Due to the number and close timing of the events, loss adjusters were challenged to meet the needs of insurers. As a result, loss adjustment expenses were higher than anticipated and insurers experienced delays in receiving reports.

**Lessons learned**
- Wording issues that arose will need to be addressed during renewals.
- Enhanced contract wording for collateral markets to ensure funds can be paid in a timely fashion without delay.

Many variables arose for each catastrophe, including around the hours clause during the wildfires, flood versus wind damage for Hurricane Harvey, and aggregation challenges. The California wildfires’ 168-hour clause highlighted the issues raised around when the burning started and ended and whether the individual fires counted as one event or several.
Global Fatalities

Exhibit 13: Top 10 Human Fatality Events

<table>
<thead>
<tr>
<th>Date(s)</th>
<th>Event</th>
<th>Location</th>
<th>Deaths</th>
<th>Economic Loss (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>August</td>
<td>Flooding</td>
<td>Sierra Leone</td>
<td>~1,141</td>
<td>30 million</td>
</tr>
<tr>
<td>August</td>
<td>Flooding</td>
<td>India</td>
<td>950</td>
<td>225 million</td>
</tr>
<tr>
<td>September 18-22</td>
<td>Hurricane Maria</td>
<td>Caribbean Islands</td>
<td>Hundreds+</td>
<td>~66 billion</td>
</tr>
<tr>
<td>November 12</td>
<td>Earthquake</td>
<td>Iran, Iraq</td>
<td>630</td>
<td>740 million</td>
</tr>
<tr>
<td>March &amp; April</td>
<td>Flooding</td>
<td>Colombia</td>
<td>420</td>
<td>Millions</td>
</tr>
<tr>
<td>September 19</td>
<td>Earthquake</td>
<td>Mexico</td>
<td>370</td>
<td>4.5 billion</td>
</tr>
<tr>
<td>December</td>
<td>Typhoon Tembin</td>
<td>Philippines, Vietnam</td>
<td>340</td>
<td>50 million</td>
</tr>
<tr>
<td>May</td>
<td>Flooding</td>
<td>Sri Lanka</td>
<td>291</td>
<td>197 million</td>
</tr>
<tr>
<td>Summer &amp; Autumn</td>
<td>Flooding</td>
<td>Zimbabwe</td>
<td>271</td>
<td>200 million</td>
</tr>
<tr>
<td>August</td>
<td>Flooding</td>
<td>Democratic Republic of the Congo</td>
<td>200</td>
<td>N/A</td>
</tr>
<tr>
<td>All Other Events</td>
<td></td>
<td></td>
<td>~4,700</td>
<td>282 billion</td>
</tr>
<tr>
<td>Totals</td>
<td></td>
<td></td>
<td>~10,000</td>
<td>353 billion</td>
</tr>
</tbody>
</table>

The number of human fatalities caused by natural disasters in 2017 was approximately 10,000. Nearly half of the top ten events occurred on the Asian continent, many of which were spawned by significant inundation and landslides in India, Sri Lanka, Nepal, and Bangladesh. However, the deadliest event was a massive landslide in Sierra Leone that left more than 1,100 people dead. Overall, the flood peril accounted for more than 60 percent of fatalities during the year.

Typhoon Tembin was officially the deadliest tropical cyclone of the year, though there remained substantial uncertainty surrounding the official death toll from Hurricane Maria in Puerto Rico. Tentative estimates listed the death toll likely in the hundreds, while other unofficial estimates indicated the toll could have been beyond 1,000. The third-deadliest peril was earthquake, which accounted for 12 percent of the annual human fatalities total. Significant tremors near the Iraq and Iran border and in Mexico each caused hundreds of fatalities.

2017 saw a higher number of natural disaster-related fatalities from those sustained in 2016 (8,224) and was a substantial 86 percent lower than the average since 2000 (71,000). The tally was also well below the median number fatalities of approximately 22,550.

Exhibit 14: Global Human Fatalities

The number of human fatalities caused by natural disasters in 2017 was approximately 10,000. Nearly half of the top ten events occurred on the Asian continent, many of which were spawned by significant inundation and landslides in India, Sri Lanka, Nepal, and Bangladesh. However, the deadliest event was a massive landslide in Sierra Leone that left more than 1,100 people dead. Overall, the flood peril accounted for more than 60 percent of fatalities during the year.

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2017 saw a higher number of natural disaster-related fatalities from those sustained in 2016 (8,224) and was a substantial 86 percent lower than the average since 2000 (71,000). The tally was also well below the median number fatalities of approximately 22,550.

Source: Aon Benfield
Natural Disasters Defined & Total Events

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

- Economic Loss: USD50 million
- Insured Loss: USD25 million
- Fatalities: 10
- Injured: 50
- Homes / Structures Damaged orFiled Claims: 2,000

Based on the noted criteria, there were at least 330 individual natural disaster events in 2017, which was 20 percent higher than the 2000-2016 average of 275. As typically expected, the second and third quarters were the most active with 87 and 113 events occurring, respectively. APAC incurred the highest number of events, which is expected given Asia’s expansive landmass and susceptibility to natural disaster events. All regions of the globe—with the exception of the Americas—registered an above average number of events.

Exhibit 15: Total Natural Disaster Events

![Chart showing total natural disaster events from 2000 to 2017.]

Source: Aon Benfield

Exhibit 16: Total Natural Disaster Events by Region

![Chart showing natural disaster events by region in 2017 and average from 2000-2016.]

Source: Aon Benfield
2017 Natural Peril Review

Peril Focus: Tropical Cyclone

In 2017, tropical cyclones generated economic losses of USD232 billion making it the costliest year on record for the peril since 2005, which had USD237 billion in registered losses. Hurricane Katrina in 2005 remains the costliest tropical cyclone with economic losses of USD156 billion in today’s dollars.

2017 was also the costliest insured loss year on record since 2005 with losses generated by the peril reaching at least USD83 billion. Insured losses generated in 2005 of USD110 billion (2017 USD) remain the highest on record for the peril during a calendar year. Hurricane Katrina also remains the costliest tropical cyclone on record in terms of insured losses at USD83 billion.

Economic losses due to tropical cyclones totaled were 396 percent higher than the 2000-2016 average of USD47 billion. The vast majority of the losses were incurred in the United States mainland (USD125 billion), followed by the Americas and Caribbean (USD95 billion), APAC (USD12 billion), and EMEA (USD67 million). It was the costliest peril of the year in terms of both economic and insured losses.

Global Activity

The overall number of global tropical cyclones was below average in 2017. Prior to any final reanalysis, there were 84 confirmed named storms that developed across all global basins. This was slightly lower than the long-term 37-year average of 86 named storms. There were 42 hurricanes, typhoons, and cyclones (storms with sustained wind speeds of at least 74 mph or 119 kph), which was 11 percent below the long-term average of 47 and the lowest annual total since 2011. 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 or 179 kph) was 19, or 5 below the long-term average of 24 and the lowest number of such storms since 2009.

In terms of global landfalls, 19 storms came ashore at Category 1 strength or above. Six of those made landfall at Category 3 strength or above. Landfall averages from 1980-2016 include 16 Category 1+ and 5 Category 3+ events. Three of the Category 3+ storm landfalls were in the Atlantic Ocean Basin, while two were recorded in the Southern Hemisphere (including the South Indian and South Pacific Ocean basins) and one in the Western Pacific Ocean Basin.

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

Exhibit 17: Global Tropical Cyclone Activity

Source: Aon Benfield
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 accumulated cyclone energy 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 2017 was 590.8, or 86 percent of the recent 10-year average of 685. It was also substantially lower than the long-term average from 1980-2016 of 768.2. Additionally, it was lower than 2016’s total of 789.4 and 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.

Only the Atlantic Basin recorded higher than average ACE during 2017, contributing 38 percent of the global total, compared to an average of approximately 15 percent, primarily due to the formation and longevity of Hurricanes Irma and Maria. All other basins recorded lower than average values of ACE.
Atlantic Ocean Basin

Losses generated by the Tropical Cyclone peril during 2017 were almost entirely driven by the trio of Atlantic Hurricanes known as HIM: Harvey, Irma, and Maria. Collectively they generated economic losses of USD220 billion during a six-week period from mid-August through the end of September. Costliest was Hurricane Harvey with economic losses of USD100 billion, largely incurred in the state of Texas, followed by Hurricane Maria, whose main impacts were felt in Dominica and Puerto Rico among other Caribbean nations, which generated economic losses of USD65 billion. The third-costliest hurricane of the Atlantic season was Hurricane Irma, which cost USD55 billion as it wrought havoc across the Caribbean and the US Southeast with a particular focus on Florida.

The same three hurricanes additionally accounted for 94 percent of the total tropical cyclone losses generated in 2017. Hurricanes Harvey, Irma, and Maria generated combined insured losses of USD80 billion out of a total of more than USD83 billion generated globally throughout the year. The costliest of the Atlantic hurricanes for the public and private insurers was Harvey, with losses of USD30 billion, followed by Maria and Irma at USD27 billion and USD23 billion, respectively.

Exhibit 20: Landfalling Tropical Cyclones in the Atlantic Basin during 2017
Pacific & Indian Ocean Basins

Away from the Atlantic Basin, the other major basins around the globe were relatively quiet in terms of overall activity. Other notable tropical cyclones during 2017 included August’s Typhoon Hato, which caused USD3.5 billion worth of damage in China and Hong Kong, and March’s Cyclone Debbie that triggered extensive flooding in eastern Australia leading to economic losses of USD2.4 billion. Typhoon Hato’s landfall was followed within a matter of days by the arrival of Tropical Storm Pakhar in the same area, which exacerbated flooding in the affected areas. Cyclone Debbie was the second costliest cyclone on record in Australia in terms of both economic and insured losses as it generated claims amounting to USD1.3 billion. Only 2011’s Cyclone Yasi cost the country more with economic losses of USD4.0 billion (2017) and insured losses of USD1.6 billion (2017 USD).

Two other tropical cyclones generated economic losses in excess of USD1.0 billion during 2017: October’s Typhoon Lan and November’s Typhoon Damrey. The majority of the damage inflicted by Lan (USD1.1 billion) was noted in Japan while Vietnam bore the brunt of Damrey (USD1.0 billion). Lan was one of five named storms to impact Japan during 2017: the others were July’s Tropical Storm Nanmadol and Typhoon Noru, September’s Typhoon Talim, and October’s Typhoon Saola. Economic losses collectively amounted to USD2.1 billion. Insurance payouts covered approximately 55 percent of these losses (USD1.2 billion). Vietnam endured its most active year since 1995 in terms of landfalling tropical cyclones with a Category 2 (November’s Typhoon Damrey) and a Category 3 (September’s Typhoon Dokson) storm making landfall there. Collectively the storms claimed more than 150 lives, damaged almost 500,000 homes, and prompted economic losses of USD1.5 billion. The Philippines saw an active end to the year with Tropical Storm Kai Tak and Typhoon Tembin impacting southern portions of the country. The storms collectively claimed more than 300 lives and caused damage to more than 37,500 homes. Economic losses were estimated at USD52 million.
Peril Focus: Severe Weather

The severe weather peril—which references severe convective storms—was again one of the leading causes of damage around the globe. Economic losses due to severe weather totaled nearly USD36 billion during 2017, above the ten-year average of USD28 billion (2017). The vast majority of the losses were incurred in the United States (USD30 billion), followed by EMEA (USD3.3 billion), APAC (USD2 billion), and the Americas (USD800 million). It was the second costliest peril of the year in terms of economic losses, following tropical cyclone.

As typically the case given its unique topography and geographic location that makes it particularly prone to severe weather outbreaks, the United States was the most active region of the globe for the peril. The U.S. alone endured nine separate events that caused economic damage of at least USD1 billion. Six of those events cost insurers at least USD1 billion—highlighting the continued financial toll of the peril. While the largest tropical cyclone events often dwarf costs from the largest severe weather events, the severe weather peril has much more annual consistency in aggregated loss cost. Tropical cyclone is much more volatile on an annual basis.

The costliest 2017 severe weather event was an outbreak that struck the United States’ Rockies, Plains, and Midwest for four days during May that caused economic losses of USD3.4 billion. At least USD2.6 billion of that total was covered by insurance. The vast majority of the damage was hail-related and impacted the greater Denver metropolitan region. Hail was the primary driver of the loss in 2017, which included billion-dollar payouts following events that affected major metro areas such as Denver, Colorado; Dallas, Texas; and Minneapolis, Minneapolis. Overall, severe weather outbreaks cost the United States roughly USD30 billion during 2017, with most of the damage occurring to the east of the Rocky Mountains.

It is worth noting that thunderstorm-related damage losses in the U.S. were the second-highest ever registered on an inflation-adjusted basis, second only to 2011. Despite 2017 ending as one of the top 5 most active years for tornado touchdowns, it ended with fewer than 20 strong tornadoes (F3/EF3+), just the second time since 1950 that this has occurred. The other time was in 1987 (15). This highlights how hail and straight-line wind is often the predominant driver of thunderstorm losses, and not tornado.

Elsewhere notable severe weather outbreaks impacted portions of Europe, Australia, South Africa, China, and Canada. None of the non-U.S. severe weather outbreaks generated economic losses in the vicinity of USD1 billion; the costliest non-U.S. event was a four-day outbreak in late June and early July that affected parts of Germany and generated insured losses in excess of USD700 million. A further two-day severe weather outbreak during August caused economic losses of USD772 million across Central Europe, particularly Poland. That event was led by an extended line of fast-moving damaging winds (known as a “derecho”), which caused major damage to the local timber industry.
Hail
Hail is the predominant driver of thunderstorm-related loss in the United States and elsewhere around the world. While tornadoes often receive most media coverage given their immense damage to structures in the immediate path, the largest-sized tornadoes (around 1 mile or 1.6 kilometers) are much smaller than the widest hail swaths—which can be several miles (kilometers) wide—and travel across dozens of miles. The impact of hailstones can leave severe damage to homes, businesses, vehicles and agriculture. Annual insured hail losses in the United States during the past decade alone are now estimated to average as high as USD10 billion, which is more than half of the total SCS-related cost.

Since the implementation of Doppler radar in the early 1990s and the continued improvement of storm reporting and social awareness, the number of large hail events has shown a 2.5 percent annual rate of growth in the United States. Large hail is defined by NOAA’s Storm Prediction Center as any hailstone of at least 2 inches (5.1 centimeters) in diameter.

As more people continue to move into high-risk areas for severe thunderstorms, it is anticipated that future storm-related losses will further increase in the coming years. The combination of more people, more exposure, and more frequent large-hail events are ingredients for this to be true.

Hail is not just a primary threat to the United States. While most billion-dollar events occur in the United States, damage costs running well into the hundreds of millions (USD) or higher are recorded with regularity in parts of Europe, Asia, and Africa. Particularly prone locations include Germany, France, Belgium, The Netherlands, Italy, Australia, Canada, China, India, Kenya, and South Africa.

Exhibit 21: U.S. Hail Reports

![Graph showing U.S. Hail Reports from 1990 to 2016](source: NOAA)
Peril Focus: Wildfire

The wildfire peril had its costliest year on record for the insurance industry in 2017, with global losses nearing USD14 billion. Overall economic losses were even higher at more than USD21 billion.

2017 was marked by two major outbreaks in California that led to the destruction of more than 10,000 structures alone. The October event in Northern California left at least 44 people dead and 185 others injured around the Napa Valley region. Total economic losses were estimated around USD13 billion of which USD11 billion was insured. This was by far the costliest wildfire outbreak ever recorded for the industry. A separate major outbreak impacted Southern California in December that cost insurers in excess of USD2.1 billion. Further wildfires throughout California and the Western United States during the summer and early autumn months prompted economic losses in excess of USD2.0 billion.

Europe recorded the largest extent of land burned by wildfires on satellite record, which dates back to 1980. For the first time in measurement history, fires consumed more than one million hectares of land across Europe. The worst affected country was Portugal where two significant outbreaks in June and October caused a combined death toll of 111, the highest on record. Economic losses due to wildfires totaled almost USD1.2 billion and the local insurance sector declared the 2017 fires the costliest natural disaster in the country’s history with payouts exceeding USD295 million. It is worth noting that wildfires burned a remarkable 6.1 percent of Portuguese national territory in 2017.

Exhibit 22: Wildfire Extents in California and Portugal

Source: GeoMAC, EFFIS & Aon Benfield
The third largest extent of land burned by wildfire in at least half a century was recorded in the United States in 2017. California, one of the largest annual contributors, accounted for nearly 13 percent; however the vast majority of the nationwide financial impact was concentrated in the Golden State. This was due to destructive fires that impacted densely populated regions, including Sonoma, Napa, and Mendocino Counties in Northern California. The Thomas Fire that impacted Southern California became the largest Californian fire in modern history. Among the notable causes of this year’s outbreaks were strong Santa Ana winds and prolonged drought conditions.

The scope of the national tragedy in Portugal was marked by historical records being broken in terms of fatalities, financial impact, and areas burned. Unlike the other four major southern European countries, Portugal fails to mitigate the impact of wildfires in the long term. According to data from EFFIS, Portugal annually accounted for nearly 13 percent of land burned by wildfires in the European Union in the 1980s, 22 percent in the 1990s, 29 percent in the 2000s and the country’s share averages at nearly 35 percent since 2010. This trend can be attributed to several interacting factors, including Portugal’s position in the path of strong Atlantic winds, rising temperatures and prolonged droughts due to a warming climate and ineffective strategies in fire mitigation. Among the most prominent factors is widespread planting of eucalyptus trees. Although being very important for the local paper industry, it is generally considered being highly flammable.

Elsewhere in 2017, wildfires of note occurred in central Chile during January and February. South Africa recorded the costliest insurance event in history, when the Knysna fires in June destroyed hundreds of homes and payouts reached USD275 million. Multiple summer fire events in Canada’s British Columbia left a combined economic cost of nearly USD250 million.
Peril Focus: Earthquake

Earthquakes generated more than USD8.2 billion in economic losses during 2017, more than half of which were incurred in Mexico (USD5.8 billion) from separate events that occurred within a week of each other. The year’s largest tremor, measured by the United States Geological Survey (USGS) at magnitude 8.2, struck offshore Mexico’s Chiapas state on September 7 and caused widespread destruction throughout several southern states with economic losses of USD1.3 billion. The year’s costliest earthquake, which was also the sixth largest in terms of magnitude (7.1), struck Mexico’s Puebla state on September 19. It was also on the 32nd anniversary of the historic 1985 event that left more than 10,000 dead in Mexico City. The tremor caused extensive damage throughout Puebla and several surrounding states, including in Mexico City. Economic losses were cited at USD4.5 billion and insured losses were roughly USD1 billion.

Elsewhere, a devastating earthquake struck the Iran-Iraq border region on November 12 that claimed at least 630 lives. It was the year’s deadliest temblor and generated economic losses of USD740 million. Other notable earthquakes struck China’s Sichuan and Xinjiang provinces in August and May respectively, Italy’s Abruzzo region on January 18, and the Greek island of Kos on July 21. All of the earthquakes were responsible for multiple casualties and each individually generated economic losses of more than USD100 million.

Nearly all of the economic and insured losses resulting from earthquakes in 2017 were incurred in Mexico, Asia, and Europe. Damage costs were well below the 2000-2016 average of nearly USD39 billion, but closer to the median of USD10 billion.

Exhibit 24: Global Earthquake Activity in 2017
Peril Focus: Other Perils

Windstorm ranked as the costliest peril for European insurers in 2017 with an overall loss just above USD2.5 billion. A total of 13 storms made notable impact in 2017, i.e. incurred at least USD50 million of insured losses. Although the number of such storms is at its highest since 2000, the overall impact for insurers was still below the long-term average due to a lack of a truly major storm. Multi-billion dollar events can occur in otherwise inactive seasons, for instance, Windstorm Kyrill in 2007. Relative unpredictability and variability creates a potential for new real-time modeling products.

Among the most significant storms of 2017 was Windstorm Herwart, which impacted Central Europe at the end of October 2017, incurring approximately EUR250 million losses to German insurers and also becoming the second costliest windstorm on record in the Czech Republic. Similar impacts on the German market were felt after the passage of storm Egon in mid-January and Xavier in early October. Another notable event was Ex-Hurricane Ophelia, which impacted the British Isles in mid-October. Although the storm became the easternmost major Atlantic hurricane on record, resulting impact on the Irish and British insurance sector turned out to be lower than was initially feared. The most notable storms for French insurers were storm Zeus in early March and Ana in December.

While a dichotomy in terms of physical effect, the drought and flood perils had notable impacts around the globe. While there were no individual events that surpassed USD10 billion in economic damage, there were at least six that had a multi-billion-dollar financial cost. Most significantly, China registered a USD7.5 billion flood loss along the Yangtze River and Southern Europe cited agricultural damage at USD6.6 billion due to extended drought conditions. The costliest event of 2017 in South America was a major flood following record rainfall in Peru during February and March that caused USD3.2 billion in damage. Other costly drought events affected the United States and China each with USD2.5 billion while Central and Northern Africa followed at USD1.9 billion.

The winter weather peril was fairly benign in 2017 as only two events had an economic cost beyond USD1.0 billion. One event impacted the Central and Eastern United States during the month of March with heavy snow, frigid temperatures and flooding. Europe endured a late season winter weather event in April as damage costs to the agricultural sector topped USD3.1 million.
2017 Climate Review

2017 was the 41st consecutive year of above average global land and sea surface 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 +0.84°C (+1.51°F) above the long-term mean, making 2017 the third-warmest year ever recorded since official data on global temperatures began being collected in 1880. This is notable because 2017 became the hottest year on record that was not marked by El Niño conditions, which typically lead to warmer global temperatures. The hottest year on record was registered in 2016 at +0.94°C (+1.69°F) above average. The anomaly data is used in conjunction with NCEI’s 20th century average of 1901 to 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.

It is worth noting that all five of the warmest years dating to 1880 have occurred since 2010. Even more remarkable, 18 out of the 19 warmest years have been registered since 2001—the lone exception being 1998. Analyzing global temperature anomaly trends is important to track changes in climate. A temperature anomaly is simply the difference of an absolute (measured) temperature versus its longer term average for that location and date. All major agencies that independently measure global temperatures use a combination of surface and satellite observations have each concluded that the Earth continues to get warmer. Some of these agencies include NOAA, NASA, the UK Met Office, and the Japan Meteorological Agency.

More heat and moisture in the atmosphere leads to more unusual weather patterns and increases the risk of extreme events around the world.

Exhibit 25: Global Land and Ocean Temperature Anomalies: 1880-2017

![Graph showing global land and ocean temperature anomalies from 1880 to 2017.](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), 2017 was a year initially marked by ENSO-neutral conditions after exiting a brief La Niña episode. Most of the year saw sea surface anomalies in the equatorial Pacific Ocean remaining between -0.5°C and +0.5°C; the threshold for ENSO-neutral conditions. By the end of the year, NOAA announced that La Niña conditions had begun and were expected to linger through the first three months of 2018. After that time, the forecast models indicated a likelihood of ENSO-neutral conditions returning by the end of the Northern Hemisphere’s spring months.

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

Exhibit 26: Phases of the El Niño/Southern Oscillation (ENSO)

Exhibit 27: ENSO Years Since 1900 (Red: El Niño / Blue: La Niña / Neutral: Gray)

<table>
<thead>
<tr>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
<th>Year</th>
</tr>
</thead>
</table>

Source: NOAA
Global Carbon Dioxide

2017 marked the second consecutive year in which averaged monthly atmospheric carbon dioxide levels did not drop below 400 parts per million (ppm). The last two years mark the first time this has happened since instrumentally-recorded measurements began in 1958. Using data provided by the National Oceanic and Atmospheric Administration’s (NOAA) Earth System Research Laboratory (ESRL) global carbon dioxide levels averaged 407 ppm in 2017—a rise of three ppm over the 2016 annual average (404 ppm). The highest monthly average concentration of almost 410 ppm was observed in May, while the lowest monthly average concentration of 403 ppm was recorded in September. May’s concentration of 410 ppm was the highest value ever recorded.

Atmospheric carbon dioxide levels have a scientifically proven correlation with global temperature: records from ice cores and the geological record show that as atmospheric concentrations of carbon dioxide increase, temperatures rise and 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, often 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 28: Global Average Atmospheric Carbon Dioxide Concentrations & Temperature Anomalies

Source: Aon Benfield & NOAA
Arctic Sea Ice

The decline of the Arctic sea ice has been well documented and regarded as one of the most visible results of a warming atmosphere during the past few decades. Arctic 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, or salinity in the Arctic Ocean, as it creates an insulation of 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. This further exacerbates melting.

Like carbon dioxide readings, the spatial extent 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 ice extent changes seasonally, with minimum in September and maximum in late Northern Hemisphere winter. Its decline is connected to rising global temperatures; the Arctic as a region has seen some of the most rapid increase in temperatures globally during the last 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 the Arctic sea ice. September minimum extent has been decreasing by about 85,000 km² (33,000 mi²) annually since 1979. However, since the mid-1990s, the Arctic has seen a much sharper decline of about 125,000 km² (45,000 mi²) every year.

In 2017, Arctic sea ice extent slightly recovered from months of record minimum extents recorded during the second half of 2016. (Note that the National Snow and Data Ice Center began collecting data in 1979). Minimum monthly sea ice extents were recorded during January (12.26 million km²), February (13.72 million km²), and March (14.09 million km²). Ice loss was not historically low during the boreal summer months (August, September, October) though ice levels were significantly lower than the 1981-2010 median and mean. A peak maximum was 14.45 million km² on March 5; while a peak minimum of 4.64 million km² was recorded on September 13.

While sea ice extent is an important variable in analyzing the health of the Arctic, sea ice thickness and age are equally as imperative. Though thickness is not the same as age, both provide essential guides to determine whether climate-related impacts are causing more accelerated warming. A 2007 study found that 57 percent of ice was at least five years old in 1987, and by 2007, that number was down to 7 percent (Maslanik et al, 2007). Despite a brief increase in multiyear ice in 2013 and 2014 following record lows in 2012, a declining trend has since resumed. Scientists believe that continued increases in atmospheric and oceanic warming and changes in wind patterns will only further reduce ice thickness and multiyear ice. Such conditions have led to accelerated sea level rise in the world’s oceans since 1993.
Exhibit 29: Arctic Sea Ice Extent: 1979-2017

Source: Fetterer et al. (2017); NSIDC
Low Risk Does Not Equate to No Risk:  A Spotlight on the California Wildfires

Dan Dick, Head of Global Catastrophe Management & Bill Fleischhacker, Executive Managing Director, Aon Benfield  
Steve Bowen, Director, Impact Forecasting

The U.S. West Coast is regularly confronted with the risk of conflagration if a wildfire is sparked. An estimated 3.6 million residential properties in California are situated within wildland-urban interface (WUI) areas with more than one million of those residences highly exposed to wildfire events, according to a 2010 Federal study.

However, the Tubbs wildfire—which rolled up with other California wildfires to result in some of the largest global reinsurance recoveries during 2017—spread into the Coffey Park neighborhood that was situated outside WUI areas. This disaster amplifies the vulnerability to wildfire exposure to protect people, homes, and businesses. But what can be learned from this wildfire to enhance disaster planning and communications—in addition to the research and resources available through agencies or organizations such as CALFIRE, FEMA, IBHS, and Firewise?

Lessons learned

- Government entities need to revisit evacuation planning to ensure both email and cell phone alerts are issued with haste. The lack of warning led to a frenzied situation in Coffey Park. And a "back to the future" siren system would act as basic supplemental measure to quickly alert residents.
- The utilities sector may have to reassess how electrical power is supplied to mountainous areas where, during violent winds, swaying electrical lines, or fallen transformers and poles often result in arcing wires that spark easily-spreadable fires.
- Since saving lives is the highest priority for emergency services, more insurers may consider contracting private firefighting operations to reduce chances of property damage. Actions could involve clearing vegetation and combustible fencing with chain saws, accessing water sources with pumps, covering vents, clearing gutters, and applying fire retardant foam spray to structures.
- Damage from wildfires in Oakland Hills and Coffey Park in 1991 and 2017, respectively, were not anticipated by catastrophe models so insurers may choose to re-explore "model miss" options that could influence the spread of risk and their reinsurance design strategies.
- The insurance industry will benefit by supporting community awareness campaigns to inspire customers to be vigilant about wildfire exposure; especially, as another Coffey Park-type event could potentially reoccur in California or even happen elsewhere under similar conditions.

Following the series of U.S. catastrophes, Aon visited the sites of Houston for Hurricane Harvey, Puerto Rico for Hurricane Maria, Florida for Irma, and Northern California for the wildfires. The team surveyed the damage and assessed how each event evolved to impact both people and properties with the goal of enhancing catastrophe models and identifying lessons for the future. Dan Dick, Bill Fleischhacker, and Steve Bowen share their experiences from the California reconnaissance trip.
2017 Global Catastrophe Review

United States

Exhibit 30: Top 5 Most Significant Events in the United States (Mainland)

<table>
<thead>
<tr>
<th>Date(s)</th>
<th>Event</th>
<th>Location</th>
<th>Deaths</th>
<th>Economic Loss (USD)</th>
<th>Insured Loss (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aug. 25 – Sept. 2</td>
<td>Hurricane Harvey</td>
<td>Texas, Louisiana</td>
<td>90</td>
<td>~100 billion</td>
<td>~30 billion</td>
</tr>
<tr>
<td>September 10-12</td>
<td>Hurricane Irma</td>
<td>Florida, South Carolina, Georgia</td>
<td>90</td>
<td>~25 billion</td>
<td>~15 billion</td>
</tr>
<tr>
<td>October 8-31</td>
<td>Wildfires</td>
<td>California</td>
<td>44</td>
<td>13 billion</td>
<td>11 billion</td>
</tr>
<tr>
<td>May 8-11</td>
<td>Severe Weather</td>
<td>Rockies, Plains, Midwest</td>
<td>0</td>
<td>3.4 billion</td>
<td>2.6 billion</td>
</tr>
<tr>
<td>Spring &amp; Summer</td>
<td>Drought</td>
<td>Plains, Rockies, West</td>
<td>N/A</td>
<td>2.5 billion</td>
<td>1.9 billion</td>
</tr>
<tr>
<td></td>
<td></td>
<td>All Other Events</td>
<td>-233</td>
<td>37 billion</td>
<td>24 billion</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td></td>
<td>~457</td>
<td>181 billion</td>
<td>84 billion</td>
</tr>
</tbody>
</table>

Exhibit 31: Map of US Natural Disasters in 2017

1 Subject to change as loss estimates are further developed
2 Includes losses sustained by private insurers and government-sponsored programs
Position of an event is determined by the most affected administrative unit or epicenter.
Economic and insured losses derived from natural catastrophes in the continental United States were the costliest since 2005, and the second costliest ever recorded on an inflation-adjusted basis. The overall economic total was USD181 billion, of which USD84 billion was covered by public and private insurers. Based on annual data from 2000-2016, economic losses in 2017 were +196 percent higher than the average (USD61 billion) and an even greater +353 percent higher than the median (USD40 billion). Insured losses were +163 percent higher than the average (USD32 billion) and an even greater +265 percent higher than the median (USD23 billion).

There were several catastrophic events that impacted the mainland United States during the year. The costliest was Hurricane Harvey, which rapidly intensified to Category 4 status prior to landfall in Texas. The storm, the first major hurricane (Category 3+) to strike the U.S. since 2005, would eventually stall across Texas and spawn record-breaking rainfall in the Houston metro region. Some areas recorded rainfall totals equal to beyond 1-in-1,000 years (or a 0.1 percent chance happening in any given year.) Historic flooding led to more than 182,000 homes and businesses sustaining major or minor damage in Texas alone. Given much of the damage was water-related and just 15 percent of homeowners in Harris County, Texas had active NFIP policies in place at the time of landfall, just USD30 billion out of the estimated USD100 billion economic toll was covered by insurance.

Hurricane Irma made multiple landfalls in Florida—the first Category 4 storm to strike the state since Charley in 2004—and caused major wind and storm surge damage to areas in the Florida Keys and the peninsula. Irma’s broad circulation would travel up the spine of Florida and later bring additional impacts to Georgia and South Carolina. Total economic damage was estimated at USD25 billion, with more than half of that amount covered by insurance.

The state of California endured two massive wildfire outbreaks in which more than 10,000 structures were destroyed. The October outbreak, led by the Tubbs Fire in the Napa Valley region, prompted a record USD11 billion in insurance payouts. That became the costliest wildfire event in history for the insurance industry. Another outbreak in December across Southern California, led by the Thomas Fire, led to another USD2.2 billion payout for insurers. The Thomas Fire became the largest fire in California since reliable local records began in 1932.

Other major U.S. events included a series of substantial hailstorms during the year that impacted major metropolitan areas including Denver, Colorado; Dallas, Texas; and Minneapolis, Minneapolis. The severe weather outbreak in May that affected Denver caused an overall damage cost of USD3.4 billion. At least five severe weather outbreaks had a minimal economic cost of USD2.0 billion, and two of those events had insured losses of at least that total as well. Severe drought conditions in the Upper Midwest, Northern Rockies and parts of the West during the spring and summer months caused more than USD2.5 billion in damage to agriculture. Additional wildfires enhanced by the drought during the summer months led to a multi-billion-dollar economic cost in parts of Washington, Oregon, Idaho, Montana, and California.

For a detailed review of all events in 2017, please visit www.aonbenfield.com/catastropheinsight and click on “Thought Leadership” to download updated monthly Global Catastrophe Recaps.
Both economic and insured losses from all natural disasters in the United States have shown positive annual rates of growth since 2000. Economic losses have grown 4.1 percent annually above the rate of inflation; while insured losses have grown by an even greater 5.5 percent. As coastal exposures and properties in more vulnerable locations grow, this is expected to lead to continued positive loss trends in the future.

Exhibit 32: United States Economic and Insured Losses (All Natural Disasters)

When analyzing weather-only related economic and insured losses since 2000, the rates of increase above inflation are identical to those of all natural disasters (+4.1 percent for economic and +5.5 percent for insured). This is due to the fact that the United States has not endured a major earthquake catastrophe in more than two decades.

Exhibit 33: United States Economic and Insured Losses (Weather Only)
Tropical cyclone, severe weather, and wildfire were the dominant perils that caused economic losses in the United States during 2017. The three perils were each significantly higher than their individual 2000-2016 average and median values. The non-tropical cyclone flooding, winter weather, drought, and earthquake perils were all lower than normal. It is worth noting that the severe weather peril was not the costliest disaster type in the U.S. for the first time since 2012.

**Exhibit 34: United States Economic Losses by Peril**

Losses resulting from Hurricanes Harvey and Irma drove a significant portion of insurance payouts. The USD45 billion in claims payouts for all tropical cyclones on the U.S. mainland was the highest for the peril since 2005. The severe weather peril was the second most expensive of the year at USD21 billion and was the second-costliest year for insurers with the peril on record. At USD13 billion, the wildfire peril had its most expensive year ever recorded for the industry.

**Exhibit 35: United States Insured Losses by Peril**

*Please note that insured losses include those sustained by private insurers and government-sponsored programs such as the National Flood Insurance Program and the Federal Crop Insurance Corporation (run by the USDA’s Risk Management Agency).*
There were at least 16 events that caused at least USD1 billion in economic losses in 2017, which was well above the 17-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), wildfire (3), tropical cyclone (2), winter weather (1), and drought (1).

Exhibit 36: United States Billion-Dollar Economic Loss Events

![Bar chart showing billion-dollar economic loss events by peril from 2000 to 2017. Severe weather led with 17 events, followed by tropical cyclone (11), wildfire (9), winter weather (8), and drought (4). Other perils included flooding and earthquake.]

There were 11 events that spawned insured losses beyond USD1 billion, which was above the 2000-2016 average of five. All of the events were weather-related. The breakdown of billion-dollar events included severe weather (6), tropical cyclone (2), wildfire (2), and drought (1).

Exhibit 37: United States Billion-Dollar Insured Loss Events

![Bar chart showing billion-dollar insured loss events by peril from 2000 to 2017. Severe weather led with 13 events, followed by tropical cyclone (7), wildfire (7), drought (5), and flooding (5). Winter weather and other perils included.]
**Americas (Non-U.S.)**

**Exhibit 38: Top 5 Most Significant Events in the Americas (Non-U.S.)**

<table>
<thead>
<tr>
<th>Date(s)</th>
<th>Event</th>
<th>Location</th>
<th>Deaths</th>
<th>Economic Loss (USD)$^9$</th>
<th>Insured Loss (USD)$^{10}$</th>
</tr>
</thead>
<tbody>
<tr>
<td>September 18-22</td>
<td>Hurricane Maria</td>
<td>Caribbean Islands</td>
<td>Hundreds+</td>
<td>~65 billion</td>
<td>~27 billion</td>
</tr>
<tr>
<td>September 4-9</td>
<td>Hurricane Irma</td>
<td>Caribbean Islands</td>
<td>44</td>
<td>~30 billion</td>
<td>~8 billion</td>
</tr>
<tr>
<td>September 19</td>
<td>Earthquake</td>
<td>Mexico</td>
<td>370</td>
<td>4.5 billion</td>
<td>1 billion</td>
</tr>
<tr>
<td>January – March</td>
<td>Flooding</td>
<td>Peru</td>
<td>124</td>
<td>3.2 billion</td>
<td>350 million</td>
</tr>
<tr>
<td>September 7</td>
<td>Earthquake</td>
<td>Mexico</td>
<td>98</td>
<td>1.3 billion</td>
<td>250 million</td>
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<tr>
<td></td>
<td><strong>All Other Events</strong></td>
<td></td>
<td>~615</td>
<td>5.0 billion</td>
<td>1.4 billion</td>
</tr>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td></td>
<td>~1,900</td>
<td>109 billion</td>
<td>38 billion</td>
</tr>
</tbody>
</table>

$^9$ Subject to change as loss estimates are further developed

$^{10}$ Includes losses sustained by private insurers and government-sponsored programs

Position of an event is determined by the most affected administrative unit or epicenter.

**Exhibit 39: Map of Americas (Non-U.S.) Natural Disasters in 2017**
Economic and insured losses derived from natural catastrophes in the Americas were the costliest ever recorded on an inflation-adjusted basis—by a large margin. The overall economic total was USD109 billion, of which USD38 billion was covered by public and private insurers. Based on annual data from 2000-2016, economic losses in 2017 were +626 percent higher than the average (USD15 billion) and a remarkable +1,167 percent higher than the median (USD8.6 billion). Insured losses were an even more exceptional +1,420 percent higher than the average (USD2.5 billion) and an even greater +2,433 percent higher than the median (USD1.5 billion).

The most prolific financial event ever recorded in the Caribbean Islands was Hurricane Maria, which left devastating impacts across Puerto Rico, Dominica, and the U.S. Virgin Islands. The storm made landfall as a high-end Category 4 storm in Puerto Rico as its high winds, coastal surge, and major inland flooding caused catastrophic damage on the island. Similar destruction was noted in Dominica, where Maria struck as a Category 5 storm. Total economic losses were estimated at upward of USD65 billion, which included significant business interruption. The event cost insurers USD27 billion, by far the costliest insured event ever recorded in this part of the world.

Prior to Maria, Hurricane Irma also left a path of destruction throughout most of the Caribbean. The prolonged Category 5 storm caused exceptional damage in Caribbean that impacted such islands as: Sint Maarten, St. Martin, St. Barthelemy, British Virgin Islands, Anguilla, Barbados, Barbuda, St. Kitts & Nevis, Turks and Caicos, Cuba, Haiti, Dominican Republic, and the southern Bahamas before later striking the U.S. mainland. Irma caused an estimated USD30 billion in damage, and of that total, at least USD8.0 billion was covered by insurance.

Mexico endured two powerful earthquakes in just 12 days’ time during September. The first, an offshore magnitude-8.2 tremor that struck offshore Chiapas, damaged tens of thousands of structures and left nearly 100 people dead in the states of Chiapas, Oaxaca, and Tabasco. The second event, a magnitude-7.1, struck the state of Puebla but extensive damage and fatalities occurred in Mexico City. At least 370 people were killed and thousands more were injured. Total combined damage from the earthquakes was estimated at nearly USD6 billion. A much smaller portion was covered by insurance.

Other major events in the Americas included significant flooding in Peru during the first quarter of 2017 that caused more than USD3.0 billion in damage, major wildfires in Chile in January and February that caused USD870 million in damages, a major wildfire in Canada’s British Columbia, and at least eight separate flood or severe weather events in Canada that cost at least USD100 million.

For a detailed review of all events in 2017, please visit www.aonbenfield.com/catastropheinsight and click on “Thought Leadership” to download updated monthly Global Catastrophe Recaps.
All economic losses have increased at a rate of 14.8 percent a year and insured losses have increased at a more substantial 32.3 percent. 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, outlier events such as the 2010 Chile earthquake and Hurricanes Maria and Irma in 2017, have skewed the data. Despite the higher rate of growth for insured losses over overall economic losses, there remains a very low level of insurance penetration in many areas, particularly in Latin America.

Exhibit 40: Americas (Non-U.S.) Economic and Insured Losses (All Natural Disasters)

Weather-related economic losses have increased at a rate of 15.1 percent a year and insured losses have increased at a more substantial 30.8 percent. However, it is important to note that these accelerated rates of growth are primarily skewed due to recent major flooding and wildfire events in Canada, and Hurricanes Maria and Irma in 2017.

Exhibit 41: Americas (Non-U.S.) Economic and Insured Losses (Weather Only)
Overall economic losses in the Americas were +626 percent above the 2000-2016 average and more than +1,110 percent higher than the median. Four perils recorded economic losses above their 17-year average and median levels in 2017. At USD95 billion, the tropical cyclone peril had its costliest year ever recorded in the region and represented 88 percent of the region’s annual losses. The other three perils—earthquake, flooding and wildfire—were slightly higher than normal. Most of the non-tropical cyclone damage was recorded across Canada, Mexico, and South America.

Exhibit 42: Americas (Non-U.S.) Economic Losses by Peril

At USD38 billion, insured losses were at historic levels for the region and massively higher than the 17-year average of USD2.5 billion and even more above the median of USD1.6 billion. Losses from the tropical cyclone peril were the primary driver of payouts for the industry, with earthquake being the only peril in 2017 to additionally exceed USD1 billion. The long-term averages further underscore the lack of insurance penetration in the Americas as only the earthquake peril had previously averaged at least USD1 billion on an annual basis.

Exhibit 43: Americas (Non-U.S.) Insured Losses by Peril
There were five natural disaster events in the Americas (Non-U.S.) that caused at least USD1 billion in economic losses in 2017, which was double the 2000-2016 average of three. There were two hurricane events (Maria and Irma), two earthquake events (separate September tremors in Mexico), and Peru flooding that crossed the minimum billion-dollar threshold. Three of the events were weather related, which equaled the 17-year average.

**Exhibit 44: Americas (Non-U.S.) Billion-Dollar Economic Loss Events**

There were three natural disaster events in the Americas (Non-U.S.) that triggered insured losses at or beyond USD1 billion in 2017. This was well above the 2000-2017 average of approximately one event every four years. The breakdown by natural disaster peril included tropical cyclone (two) and earthquake (one). 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.

**Exhibit 45: Americas (Non-U.S.) Billion-Dollar Insured Loss Events**
Using the Latest Weather Data in European Catastrophe Modeling

Aidan Brocklehurst
Catastrophe Model Developer, Impact Forecasting

As windstorms became the costliest peril for the industry in EMEA with 2017 losses running over USD2.5 billion, a wealth of observational data was readily available to help understand their impact. Whether it is weather station records, forecasts, or human observations, Impact Forecasting uses this data to test, validate, and improve existing models and in the development of new products.

For example, to help insurers estimate the impact of costly windstorms before they take place, Impact Forecasting has developed its Automated Event Response service that calculates losses for individual portfolio—based on forecasts and station observations—for an early overview of the potential risks. This works by:

- ICON-EU gust forecasts covering Europe for 72 hours are received once a day and automatically turned into ELEMENTS scenarios that enable an estimation of its impact in advance of the event. While wind gust forecasts days in advance may not always accurately predict what occurs, an advance warning empowers insurers by enabling them to make necessary preparations when an event approaches.

- Immediately following the storm, a post-event scenario is built using weather station gust recordings to give a first estimation of the impact of an event before estimations based on loss reports. As with advance warnings, quick estimates of the severity of an event can prove useful to insurers in planning their response and allocating resources.

After an event has passed is when loss estimates from insurance companies can help test current vulnerabilities within Impact Forecasting’s European windstorm model or develop bespoke models. A bespoke model may be required when a company’s portfolio has unique characteristics (such as type of risk or geography) or its existing vulnerabilities are not an appropriate representation of past and future loss experience. Loss data and hazard reports, alongside engineering simulations, enable the development of new vulnerability functions suited to a particular portfolio such as churches and other religious buildings, greenhouses, or exposure concentrated by the coast.

Whether it is weather station records, forecasts, or human observations, Impact Forecasting uses this data to test, validate, and improve our existing models and in the development of new products.
EMEA (Europe, Middle East & Africa)

Exhibit 46: Top 5 Most Significant Events in EMEA

<table>
<thead>
<tr>
<th>Date(s)</th>
<th>Event</th>
<th>Location</th>
<th>Deaths</th>
<th>Economic Loss (USD)(^{11})</th>
<th>Insured Loss (USD)(^{11,12})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Summer &amp; Autumn</td>
<td>Drought</td>
<td>Southern Europe</td>
<td>N/A</td>
<td>6.6 billion</td>
<td>700 million</td>
</tr>
<tr>
<td>October 15-16</td>
<td>Wildfire</td>
<td>Portugal</td>
<td>45</td>
<td>875 million</td>
<td>270 million</td>
</tr>
<tr>
<td>November 12</td>
<td>Earthquake</td>
<td>Iran, Iraq</td>
<td>630</td>
<td>740 million</td>
<td>25 million</td>
</tr>
<tr>
<td>June 22-25</td>
<td>Severe Weather</td>
<td>Central Europe</td>
<td>0</td>
<td>705 million</td>
<td>635 million</td>
</tr>
<tr>
<td>October 29-30</td>
<td>Windstorm Herwart</td>
<td>Central Europe</td>
<td>10</td>
<td>595 million</td>
<td>445 million</td>
</tr>
<tr>
<td></td>
<td><strong>All Other Events</strong></td>
<td></td>
<td>-2,450</td>
<td>16 billion</td>
<td>4.6 billion</td>
</tr>
<tr>
<td></td>
<td><strong>Totals</strong></td>
<td></td>
<td>-3,200</td>
<td>25 billion</td>
<td>7.0 billion</td>
</tr>
</tbody>
</table>

\(^{11}\) Subject to change as loss estimates are further developed
\(^{11,12}\) Includes losses sustained by private insurers and government-sponsored programs
Position of an event is determined by the most affected administrative unit or epicenter.

Exhibit 47: Map of EMEA Natural Disasters in 2017

Peril
- Drought
- Earthquake
- European Windstorm
- Flooding
- Severe Weather
- Tropical Cyclone
- Wildfire
- Winter Weather

Economic Loss
- 50 - 250 M
- 250 - 1,000 M
- > 1,000 M
Overall economic and insured losses that were caused by natural catastrophes in Europe, Middle East, and Africa in 2017 were below their long-term normal values. Total economic losses are estimated at more than USD25 billion, which is 1.2 percent below the 17-year average. Despite several record-breaking events, insurers across the region counted losses of nearly USD7.0 billion, or very near the long-term average. 2017 thus became the fourth consecutive year in which EMEA insurers sustained losses of less than USD10 billion. Comparing the overall data with the median of the same period, economic losses were 4 percent lower, while insured losses were actually 16 percent higher.

Severe drought that affected southern Europe, particularly the Iberian Peninsula and Italy, caused significant economic losses in the agricultural sector. The Iberian drought was described as one of the worst in history. Spain experienced the second warmest summer on record, surpassed only by 2003. Several stations broke historical records as the mercury topped 45°C (113°F). Prolonged drought in Portugal was also one of the main causes of the destructive wildfire outbreaks. Italian farmers counted exceptional losses across all regions. The highest economic loss totals were estimated in Spain (USD4.3 billion) and Italy (USD2.3 billion). Elsewhere in EMEA, extreme drought impacted the Horn of Africa and caused substantial economic losses. Significant agricultural losses were incurred not only by drought. Severe cold blasts in April and May incurred more than USD3 billion of economic losses throughout Central and Western Europe.

The most destructive and deadly wildfire season on record impacted Central and Northern Portugal. Two significant outbreaks in June and October caused 111 fatalities, economic losses exceeding USD1.2 billion and became the costliest natural disaster event on record for the local insurance industry. Another significant wildfire outbreak hit Western Cape region in South Africa, generating the costliest insurance event on record, with loss estimated at USD275 million.

European Windstorm ranked again as the costliest peril for European insurers in 2017, with total insured losses estimated at approximately USD2.5 billion. Otherwise the active season did not generate any significant cost, as no storm exceeded the USD1 billion dollar mark. Among the most significant storms was Windstorm Herwart, which impacted Central Europe in late October. Severe weather peril generated several notable events, including June 22-25 storms in Germany, August 10-11 derecho windstorm in Poland and two significant July storms in Istanbul, Turkey. The deadliest natural disaster event of 2017 occurred in Sierra Leone, where 1,141 people died in August due to massive mudslides.

For a detailed review of all events in 2017, please visit www.aonbenfield.com/catastropheinsight and click on “Thought Leadership” to download updated monthly Global Catastrophe Recaps.
Since 2000, economic losses incurred in EMEA stagnated with a slight annual growth of 1 percent on an inflation-adjusted basis. From the insurance perspective, financial impact of natural disasters has shown a minor growth rate of 1.8 percent. For the past four years, overall insured losses remained relatively stable. The insurance industry in EMEA has not incurred more than USD10 billion in losses since 2013.

**Exhibit 48: EMEA Economic and Insured Losses (All Natural Disasters)**

Economic losses caused by weather disasters in EMEA in 2017 were at the highest level since 2013. For the past 18 years, overall financial impact showed a minor decreasing trend of 1 percent, while insured losses shown a positive trend of approximately 1.4 percent.

**Exhibit 49: EMEA Economic and Insured Losses (Weather Only)**
The costliest peril from the economic perspective in EMEA in 2017 was drought. Combined losses from several notable events in Southern Europe and Eastern Africa exceeded USD9 billion, which was more than 4.5 times higher than the long-term average. Flooding saw its least costly year since 2008 and generated losses of less than a fourth of the 17-year average. All perils except flooding were above their long-term median values.

Exhibit 50: EMEA Economic Losses by Peril

European windstorm and severe weather perils accounted for more than 64 percent of all insured losses incurred in EMEA in 2017 and both were above their long-term mean and median values. Among other perils that exceeded their normals were wildfire, drought, and winter weather. Flooding, which usually ranks among the costliest perils, generated the lowest insured loss total since 2008.

Exhibit 51: EMEA Insured Losses by Peril
There were just three natural disasters in the EMEA region that caused at least USD1 billion in economic losses in 2017, two of which were drought-related and one caused by winter weather (freeze). This was below the 2000-2016 average of five, and also below the five incurred in 2016. All three of the disasters were weather-related, which was below the average of four.

**Exhibit 52: EMEA Billion-Dollar Economic Loss Events**

<table>
<thead>
<tr>
<th>Year</th>
<th>Flooding</th>
<th>Drought</th>
<th>EU Windstorm</th>
<th>Earthquake</th>
<th>Severe Weather</th>
<th>Wildfire</th>
<th>Winter Weather</th>
<th>Tropical Cyclone</th>
<th>Other</th>
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<tbody>
<tr>
<td>2000</td>
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<td>7</td>
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</tr>
</tbody>
</table>

Source: Aon Benfield

For the first time since 2006, there were no individual events that caused more than USD1 billion in insured losses. In a typical year, there are usually two natural disaster events and one weather-related event in EMEA that reach the billion-dollar threshold.

**Exhibit 53: EMEA Billion-Dollar Insured Loss Events**

<table>
<thead>
<tr>
<th>Year</th>
<th>EU Windstorm</th>
<th>Flooding</th>
<th>Severe Weather</th>
<th>Earthquake</th>
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<td>0</td>
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<tr>
<td>2015</td>
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<td>0</td>
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Source: Aon Benfield
Measuring and Managing Risks for Japan Earthquake & Tsunami

Jeongmin Han, Ph.D.
Catastrophe Model Developer, Impact Forecasting

The 2011 Tohoku and the 2016 Kumamoto earthquakes were the two costliest events recorded in Japan, leading to insured losses of USD35 billion and USD5.5 billion, respectively. The 2011 Tohoku megathrust earthquake highlighted the importance of identifying unforeseen risks and accounting for an unexpected extreme event in insurers’ risk management and risk transfer strategies to prevent capital depletion. In case of the 2016 Kumamoto earthquake, a series of sequential earthquakes struck near industrial facilities, including automotive manufacturing and electronic industries, that demonstrated how a natural disaster could cause a serious disruption in the supply chain for downstream production on global scale.

Japan’s non-life re/insurance industry has continued to evolve and adapt to changes in global market dynamics—notably in the face of increasing insurance capacity and diversified risk transfer strategies—to protect earnings and capital against these major catastrophe risks of earthquake and tsunami.

With a 50-60 percent take up in personal lines coverage for earthquake cover, plus a rise in demand from corporates, Japanese insurers are increasingly willing to offer clients the coverage that they need. In turn, reinsurance plays an important part of Japanese insurers’ ability to offer a sustainably-priced earthquake product to their customers and catastrophe models are increasingly influential in driving the reinsurance purchase and determining the level of insurance protection. Today, insurers buy significantly more per occurrence reinsurance limit.

From a catastrophe modeling viewpoint, the experience from significant earthquakes provided an opportunity to re-evaluate and improve performance of catastrophe models through a large amount of damage and claims data. In order to accurately evaluate adequacy of insurance protection capacity and the expected losses, whether direct or indirect, it is essential for models and loss calculation platforms to offer users a greater level of flexibility. This is to accommodate complex policy conditions and insured exposures at different resolutions, while the model needs to be tested and verified in a transparent manner.

Modeling for the future
Development of Impact Forecasting’s Japan earthquake and tsunami model is another important step in this direction. The model incorporates the latest time-dependent earthquake occurrence probabilities and tsunami modeling through sophisticated two-dimensional hydrodynamic simulation by considering flood and coastal defence structures. Based on individual insurance companies’ unique exposure and insurance policy conditions, with the associated claims and the loss histories, the model is tailored to improve its predictive performance. Comprehensive model tests were performed to increase the model’s robustness, credibility, and transparency.

Impact Forecasting’s new Japan earthquake and tsunami model—to be launched on the ELEMENTS loss calculation platform in mid-2018—will enable accurate assessment of catastrophe risks on insured exposure for effective risk management, while meeting high standards for regulatory requirements, such as Solvency II, for enhanced risk governance.
APAC (Asia & Oceania)

Exhibit 54: Top 5 Most Significant Events in APAC

<table>
<thead>
<tr>
<th>Date(s)</th>
<th>Event</th>
<th>Location</th>
<th>Deaths</th>
<th>Economic Loss (USD)</th>
<th>Insured Loss (USD)</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 22 - July 5</td>
<td>Flooding</td>
<td>China</td>
<td>116</td>
<td>7.5 billion</td>
<td>300 million</td>
</tr>
<tr>
<td>August 23-25</td>
<td>Typhoon Hato</td>
<td>China, Hong Kong</td>
<td>22</td>
<td>3.5 billion</td>
<td>250 million</td>
</tr>
<tr>
<td>March 27-31</td>
<td>Cyclone Debbie</td>
<td>Australia</td>
<td>10</td>
<td>2.4 billion</td>
<td>1.3 billion</td>
</tr>
<tr>
<td>November 2-5</td>
<td>Typhoon Damrey</td>
<td>Vietnam, Philippines</td>
<td>114</td>
<td>1.0 billion</td>
<td>10 million</td>
</tr>
<tr>
<td>August 11-31</td>
<td>Flooding</td>
<td>India</td>
<td>950</td>
<td>225 million</td>
<td>15 million</td>
</tr>
</tbody>
</table>

All Other Events: ~3,023 deaths, ~24 billion economic loss, ~2.9 billion insured loss

Totals: ~4,235 deaths, 39 billion economic loss, 5 billion insured loss

Exhibit 55: Map of APAC Natural Disasters in 2017

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

Position of an event is determined by the most affected administrative unit or epicenter.
Economic and insured losses derived from natural catastrophes in APAC (Asia Pacific) were both substantially lower than the 2000-2016 norms and the lowest since 2009 (economic) and 2012 (insured). The region incurred the second lowest economic costs resulting from natural disasters in the world after the United States mainland and the Americas: only EMEA incurred lower losses during 2017. The USD39 billion in economic losses during in 2017 were 52 percent below the 2000-2016 average (USD82 billion); while the nearly USD5.0 billion in insured losses were also 52 percent lower than average (USD10 billion). Conducting loss analyses on a median basis produced significantly different results. This plays into how the loss averages are heavily skewed given outlier years in the region such as 2011. When analyzing economic losses on a median level since 2000, they were just 13 percent lower. Insured losses were actually 34 percent higher than the median during the same timeframe.

The costliest single event in Asia Pacific was a flooding event that occurred along China’s Yangtze River Basin Region from June 22 – July 5. The flooding was triggered by heavy Mei-Yu (monsoonal) rainfall that affected 11 provinces and inundated 412,600 homes. An additional flood event struck multiple northeastern Chinese provinces from July 13-17 that damaged more than 58,000 homes and prompted economic losses of USD4.5 billion. Insurance covered just a fraction of the losses from both of the flood events. Elsewhere, significant floods impacted Thailand during January and India during the summer monsoon season. Economic losses due to the flooding in Thailand throughout the month of January were expected to reach USD860 million, fewer than six percent of which was expected to be covered by insurance. From August 11-31, flooding in Northeastern India claimed an estimated 950 lives. The economic cost of the floods that damaged some 50,000 homes was estimated at USD225 million.

The tropical cyclone peril left a heavy financial toll in APAC in 2017. The costliest tropical cyclone was August’s Typhoon Hato which triggered extensive flooding in and around the Pearl River Delta region leading to losses of USD3.5 billion. Cyclone Debbie, which struck Eastern Australia at the end of March, was the country’s second-costliest cyclone for the insurance industry with losses of USD1.3 billion from nearly 74,000 claims. The deadliest tropical cyclone of the year in the region was November’s Typhoon Damrey, which was a rare USD1 billion economic loss event for Vietnam: an estimated 114 people were killed in Vietnam and the Philippines as a result of the tropical cyclone.

The drought and severe weather perils were the only other perils to cross the USD1 billion mark in terms of economic losses in APAC during 2017. China accounted for the bulk of drought losses as four northeastern provinces endured a months-long drought from May–July that cost USD2.5 billion. Economic losses due to severe weather were driven by multiple events in Australia and China.

For a detailed review of all events in 2017, please visit www.aonbenfield.com/catastropheinsight and click on “Thought Leadership” to download updated monthly Global Catastrophe Recaps.
Since 2000, economic losses in Asia Pacific have shown an annual increase of 10.4 percent, while insured losses have grown at an expedited 15.4 percent. 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.

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

When analyzing weather-only disaster losses in Asia Pacific since 2000, the rate of growth is 8 percent on an economic basis. That percentage rises to 11.7 percent on an insurance basis. As mentioned previously, with continued growth of insurance penetration across Asia Pacific, it is expected that insured losses will further increase at a faster pace than overall economic losses.

Exhibit 57: APAC Economic and Insured Losses (Weather Only)
The two costliest perils (flooding and tropical cyclone) caused the vast majority of economic losses in Asia Pacific, combining to equal 85 percent of the damage. Despite this, every peril—with the exception of severe weather—was below its 2000-2016 average. The same was true when compared on a median basis, except flooding, severe weather, and drought were higher.

Exhibit 58: APAC Economic Losses by Peril

The only peril that experienced much higher than average insured losses in APAC was tropical cyclone. This was primarily due to landfalling tropical cyclones around the Pearl River Delta (China & Hong Kong) and in Eastern Australia. At USD2.8 billion, it was the costliest peril of the year in the region and 47 percent above its longer term average (USD1.9 billion). The only other perils that were slightly above their averages were severe weather and drought. All other perils were well below average, but closer to the median.

It remains worth noting that despite the very high economic cost of natural disasters in the region only 13 percent of disaster losses in 2017 were covered by insurance.

Exhibit 59: APAC Insured Losses by Peril

Please note that insured losses include those sustained by private insurers and government-sponsored programs.
There were eight separate natural disaster events that caused more than USD1 billion in 2017 economic losses in Asia Pacific, which was below the 2000-2016 average of 10. This was the lowest number of billion-dollar economic loss events in the region since 2009, which also saw just eight such events; 2016 saw 13 events. It was also the first time since 2012 that no earthquake event in the region exceeded the billion-dollar threshold. All of the events were weather-related, which was one event below the 17-year-average (nine). The breakdown of billion-dollar event perils types included tropical cyclone (four), flooding (three), and drought (one).

Exhibit 60: APAC Billion-Dollar Economic Loss Events

Just one natural disaster event triggered insured losses beyond USD1 billion in 2017, which was below the 17-year average (two). That event was Cyclone Debbie, which struck Australia’s east coast in March and prompted major flooding. The only other event to prompt insured losses greater than USD0.5 billion was October’s Typhoon Lan, which struck Japan and also impacted the Philippines.

Exhibit 61: APAC Billion-Dollar Insured Loss Events
For further information and in-depth data, including the full list of all 2017 natural disaster events, please view the Companion Volume to the Weather, Climate, & Catastrophe Insight report at http://aon.io/if-companion-volume-2018.

About Impact Forecasting

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

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