Swiss Re Institute

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# sigma

## Natural catastrophes and man-made disasters in 2017: a year of record-breaking losses



sigma 50 YEARS

# Foreword

This year we celebrate the 50th anniversary of *sigma*, the flagship publication of the Swiss Re Institute´s research portfolio. Over the last half century, *sigma* has provided thought leadership spanning the ever-evolving risk landscape facing society, the macro and regulatory environments and their impact on insurance markets, and industry-specific topics such as underwriting cycles and distribution channels. As the industry's leading research publication, *sigma* has been and remains a central pillar of Swiss Re's vision to make the world more resilient.

As the first edition of *sigma* in 2018, we are pleased to bring you our annual report providing data on and in-depth analysis of recent major natural and man-made disasters. Our first-ever *sigma* report on natural catastrophes (nat cat) was published in 1969, and nat cat has been a mainstay of the series ever since. In "*sigma* No. 12/1969: Insurance against power of nature damage and its problems", our objective was to "point out the nature and extent of power of nature damage" ... by which "we mean events caused by the forces of nature."

Fifty years on, the "forces of nature" continue to inflict devastation on communities all around the world. By far the largest nat cat events in 2017 were a series of hurricanes that hit the Caribbean and the US. Major hurricanes have struck the same region many times before, as reported in *sigma* No. 12/1969: "While storm catastrophes occur in many parts of the world, the Caribbean area and the East coast of the United States seem to be affected the most frequently." Prior to 1969, "the storm year with by far the highest insurance payments was 1965, when "Betsy" became the most costly hurricane in American insurance history and also affected insurance on a worldwide scale, generally through reinsurance. Including the damage to movable property, mainly motor car and transport insurance losses, a total of $ 715 million was paid out." [1]

Equivalent to around 0.5% of US gross domestic product (GDP), the scale of the headline insurance losses from Hurricanes Harvey, Irma and Maria in 2017 are significantly more alarming than those from Betsy (0.2% of GDP), even allowing for inflation. That is not to say, however, that the impact Betsy had on peoples´ lives in 1965 was any less devastating than that experienced by many last year.

Nat cat events come in many different forms: other weather events, earthquakes, flooding and wildfires to name but a few. In the next 50 years, the nat cat risks will continue to evolve as changing variables like a warming climate, growing populations and urbanisation drive (and likely expand) the loss-potential of natural world hazards. *sigma* will strive to develop better understanding of all aspects of nat cat events to help society find solutions that better mitigate the risk and fallout of these devastating events.

Please visit the *sigma* 50 years section on the Swiss Re Institute website to find out more about the evolution of *sigma*, and the breadth and depth of our overall research offering. You can access this at www.institute.swissre.com/sigma50years.

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1 *sigma* No. 12/1969: Insurance against power of nature damage and its problems, Swiss Re.

# Executive summary

Insured losses from catastrophe events in 2017 were USD 144 billion, the highest ever.

Total insured losses from natural catastrophes and large man-made disasters were USD 144 billion in 2017. An active hurricane season in the North Atlantic, and a series of wildfire, thunderstorm and severe precipitation events across different regions pushed global catastrophe claims to their highest level ever recorded in a single year. Total economic losses were USD 337 billion, making an all-peril global catastrophe protection gap of USD 193 billion in 2017. Globally, more than 11 000 people lost their lives or went missing in disasters, while millions were left homeless.

The North Atlantic hurricane season was the costliest since 2005.

A notable feature of last year's losses is that atmospherically-induced risk factors contributed the largest part. In particular, a cluster of category 4+ hurricanes (Harvey, Irma and Maria (HIM)) in the North Atlantic left a trail of destruction across the Caribbean Islands, Puerto Rico, Texas and parts of western Florida. According to latest estimates, overall insured losses from HIM were around USD 92 billion. The hurricanes struck multiple locations in quick succession and impacted many lines of business. The final loss total will only be known once all claims have been processed but even so, 2017 is likely to go down as one of the costliest North Atlantic hurricane seasons on record. Ongoing urbanisation, human development in exposed coastal territories and effects of climate warming added strongly to the mix, and will likely do so again in the future.

...and it was a record year for wildfire losses.

In other disasters, wildfires ravaged parts of California and other countries. Insured losses from wildfires worldwide last year were the highest ever recorded, totalling USD 14 billion. Projected changes in climate, including warmer temperatures and prolonged periods of drought, are expected to continue to increase the frequency and severity of large fire events. Associated insurance losses will likely grow with more assets exposed to fire risk such as, for instance, the many new homes in the US that have been built on land adjacent to forests and undeveloped natural areas.

Heavy flooding events highlighted the vulnerability of today's urban environments.

There were also a number of severe precipitation events in 2017, which once again highlighted the vulnerability of an increasingly urbanised world to flood events. Coastal megacities such as Houston have repeatedly suffered major flood events in recent years. And in last year's monsoon season, very heavy and long running rains caused huge damage and loss of life in Nepal, India and Bangladesh. The severity of precipitation cannot be controlled, but higher investment in flood protection defences and urban planning can strengthen hazard mitigation.

Hurricane events of similar and larger magnitude than HIM will likely happen more frequently in the future.

This *sigma* includes a special chapter on HIM. From a risk management perspective, the HIM experience highlights that aside from focus on the severity of a single storm, hurricane frequency is an as-important variable to consider in modelling loss scenarios. So too are secondary risk factors like excessive rainfall that can come with hurricanes, as was the case of Harvey which led to widespread flooding in Houston. Indications are that the North Atlantic remains in an active phase of hurricane activity, and climate models predict more frequent occurrence of various characteristics observed in the HIM storms. The follow-through is that hurricane clustering will likely occur more frequently in the future. This is cause for concern, not least because HIM do not represent a worst-case scenario: Swiss Re's natural catastrophe model contains various scenarios where annual insured losses resulting from hurricanes exceed USD 250 billion. In the interests of societal resilience, further research on clustering of hurricanes and the impact of global warming on storm formation is required.

Insurance already helps societies recover from disaster events like HIM, and more can be done.

It may take a long time for communities in the Caribbean to recover from the wrath of HIM. Despite insurance industry pay outs, the amount of uninsured damage remains large. The Caribbean Catastrophe Risk Insurance Facility has covered part of the losses, paying out USD 54 million to help those Caribbean islands affected by Irma and Maria, which provided governments with liquidity for immediate post-disaster response efforts. The fast payout (within 14 days) and subsequent liquidity, while small relative to the overall losses, highlights an important benefit that insurance can provide, and speaks to the utility of insurance in reducing existing protection gaps.

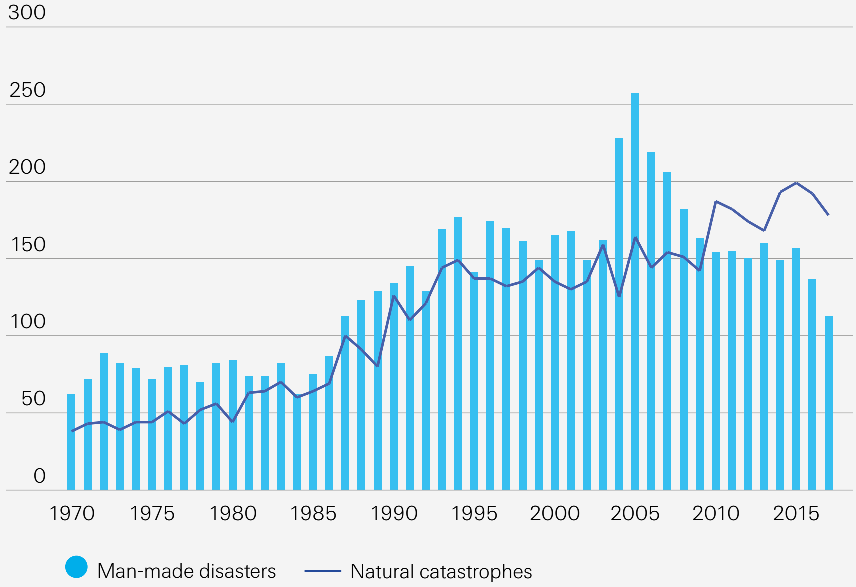
# Catastrophes in 2017: global overview

## Number of events: 301

There were 183 natural and 118 man-made disasters in 2017.

In terms of *sigma* criteria, there were 301 catastrophes worldwide in 2017, down from 329 in 2016. There were 183 natural catastrophes (compared with 192 in 2016), and 118 man-made disasters (down from 137).

**Figure 1**
Number of catastrophic events, 1970–2017




Source: Swiss Re Institute

The *sigma* event selection criteria.

To classify as a catastrophe according to *sigma* criteria, the economic losses, insured claims or casualties associated with an event must exceed just one of the following thresholds.

**Table 1**
*sigma* event selection criteria for 2017

| | | |
|---|---|---|
| **Insured losses (claims):** | | |
| | Maritime disasters | USD 20.3 million |
| | Aviation | USD 40.7 million |
| | Other losses | USD 50.5 million |
| *or* Total economic losses: | | USD 101 million |
| *or* Casualties | | |
| | Dead or missing | 20 |
| | Injured | 50 |
| | Homeless | 2000 |

Source: Swiss Re Institute

## Number of victims: more than 11 000

More than 8000 people died or went missing in natural catastrophes …

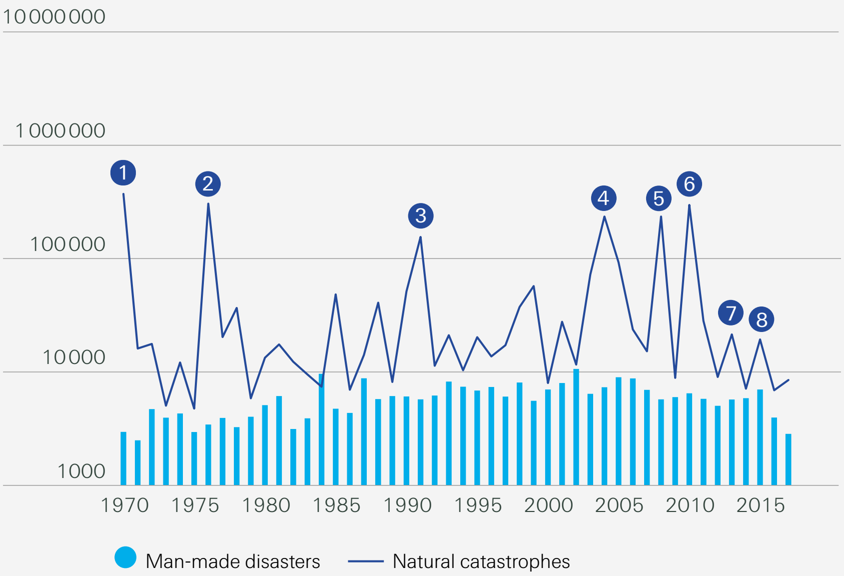
More than 11 000 people lost their lives or went missing in natural and man-made disasters in 2017, more than 2016 but still one of the lowest in a single year according to *sigma* records. A landslide and floods in Sierra Leone in mid-August claimed most lives, with 1141 people declared dead or missing. Elsewhere, heavy monsoon rains in India, Nepal and Bangladesh led to more than 1000 deaths. Globally, there were more than 8000 victims of natural catastrophes in 2017.

… and around 3000 perished in man-made disasters.

Man-made disasters resulted in roughly 3000 deaths, compared to around 4000 in 2016. A bomb explosion in a mosque in Egypt claimed 311 lives, the deadliest event of the year. The total number of victims from terrorism was 731, up from 601 in 2016. The number of reported deaths in maritime disasters fell to 1163 from 1542, although many more are believed to have died in unreported incidents of boats carrying migrants sinking. Other man-made disasters included the collapse of a garbage dam in Addis Ababa, Ethiopia, in which 113 people died. Aviation disasters claimed 165 victims, with most of the fatalities (122) in a plane crash in Myanmar in June.

**Figure 2**
Number of victims, 1970–2017

1 1970: Bangladesh storm
2 1976: Tangshan earthquake, China
3 1991: Cyclone Gorky, Bangladesh
4 2004: Indian Ocean earthquake and tsunami
5 2008: Cyclone Nargis, Myanmar
6 2010: Haiti earthquake
7 2013: Typhoon Haiyan, Philippines
8 2015: Earthquake in Nepal




Note: scale is logarithmic - the number of victims increases tenfold per band
Source: Swiss Re Institute

## Total economic losses: USD 337 billion

Economic losses in 2017 well above the 10-year average.

Economic losses from natural catastrophes and man-made disasters across the world were an estimated USD 337 billion in 2017. This was close to double the 2016 total (USD 180 billion), and well above the inflation-adjusted average of USD 190 billion of the previous 10 years. Catastrophe losses in 2017 were 0.44% of global gross domestic product (GDP), significantly above the previous 10-year average of 0.25%.

Global natural catastrophe-related losses were around USD 330 billion.

Natural catastrophe-related economic losses were around USD 330 billion in 2017, coming mostly from hurricanes, severe storms, wildfires, floods and other weather events in North America, the Caribbean and Europe. Man-made disasters are estimated to have caused USD 7 billion of the economic losses, down from USD 10 billion in 2016.

# Catastrophes in 2017: global overview

**Table 2**
Economic losses, in USD billion and as a % of global GDP, 2017

| Regions | in USD bn | in % of GDP |
|---|---|---|
| North America | 244 | 1.17% |
| Latin America & Caribbean | 32 | 0.59% |
| Europe | 24 | 0.12% |
| Africa | 3 | 0.14% |
| Asia | 31 | 0.11% |
| Oceania/Australia | 3 | 0.22% |
| Seas/space | 0 | |
| **Total** | **337** | |
| World total | | 0.44% |
| 10-year average* | 190 | 0.25% |

*inflation adjusted

Source: Swiss Re Institute

## Insured losses: USD 144 billion

Insured losses were USD 144 billion, the highest ever recorded …

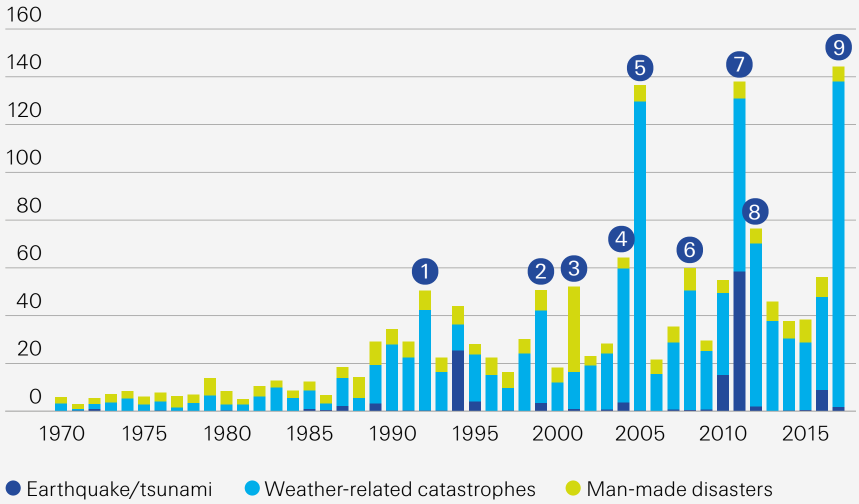
Insurance covered close to USD 144 billion – more than two fifths – of the economic losses from natural and man-made disasters in 2017, the highest ever on *sigma* records. Insured claims were up from USD 56 billion in 2016, and above the inflation-adjusted annual average of the previous 10-years (USD 58 billion). The record level of annual losses was based on payouts related to three major hurricanes in the US (Harvey, Irma and Maria), wildfire outbreaks in California, and many thunderstorms, windstorms and other severe weather events in the US and around the world. Overall natural catastrophes resulted in claims of close to USD 138 billion, significantly above the previous 10-year annual average (USD 50 billion). Insured losses from man-made disasters were around USD 6 billion, down from USD 8 billion in 2016.

...and equivalent to 0.19% of GDP.

The natural catastrophe-associated insured losses were 0.18% of world GDP in 2017 and 8% of global non-life direct premiums written (DPW), above the respective 10-year annual averages of 0.07% and 3.2%. Insured losses from natural catastrophes and man-made disasters were 0.19% of GDP and 8.7% of DPW.

**Figure 3**
Insured catastrophe losses 1970–2017 in USD billion, at 2017 prices

1 1992: Hurricane Andrew
2 1999: Winter Storm Lothar
3 2001: World Trade Center
4 2004: Hurricanes Ivan, Charley, Frances
5 2005: Hurricanes Katrina, Rita, Wilma
6 2008: Hurricanes Ike, Gustav
7 2011: Japan, NZ earthquakes, Thailand flood
8 2012: Hurricane Sandy
9 2017: Hurricane Harvey, Irma, Maria




Source: Swiss Re Institute

The largest insured-loss event of the year was Hurricane Maria.

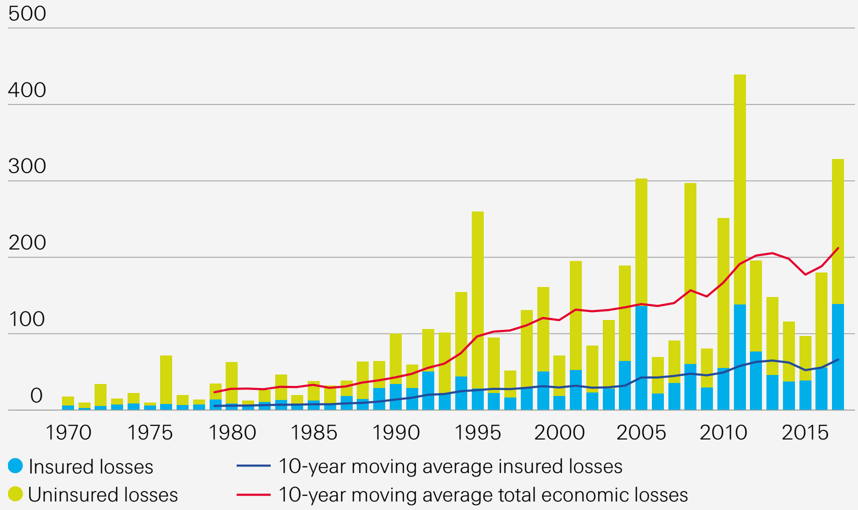
The largest insurance loss-event globally in 2017 was Hurricane Maria in the Caribbean and Puerto Rico, which triggered claims of USD 32 billion. Next were Hurricanes Irma and Harvey, each resulting in estimated insured losses of USD 30 billion across the Caribbean and the US. Fifteen disasters resulted in insurance losses of USD 1 billion or more, compared with 12 such events in 2016.

The global insurance protection gap was USD 193 billion in 2017.

Figure 4 shows the difference between insured and economic losses over time, known as the protection gap. It is the financial loss generated by catastrophes not covered by insurance. In 2017, the global protection gap was around USD 193 billion. The rate of growth of economic losses has outpaced the growth of insured losses overt the last 26 years. In terms of 10-year rolling averages, insured losses grew by 5.4% between 1991 and 2017, and economic losses by 5.9%.

**Figure 4**
Insured vs uninsured losses, 1970 – 2017, in USD billion at 2017 prices

Economic losses = insured + uninsured losses




Source: Swiss Re Institute

# Regional overview

By region, insured losses were highest in North America in 2017.

Tropical cyclones caused the highest losses in 2017. By region, insurance losses were highest in North America, most coming from hurricane events. There were also a number of severe flood events in 2017, notably in Asia and the US, and outbreaks of major wildfires in many regions.

**Table 3**
Number of events, victims economic and insured losses by region, 2017

| | | | | Insured losses | | Economic losses | |
|---|---|---|---|---|---|---|---|
| **Region** | **Number** | **Victims** | **in %** | **in USD bn** | **in %** | **in USD bn** | **in %** |
| North America | 66 | 466 | 4.1% | 119.1 | 82.5% | 244.2 | 72.4% |
| Latin America & Caribbean | 19 | 1375 | 12.1% | 5.1 | 3.5% | 31.6 | 9.4% |
| Europe | 46 | 536 | 4.7% | 12.0 | 8.3% | 23.7 | 7.0% |
| Africa | 40 | 2919 | 25.6% | 0.8 | 0.5% | 2.9 | 0.9% |
| Asia | 112 | 5546 | 48.6% | 5.0 | 3.5% | 31.2 | 9.2% |
| Oceania/Australia | 5 | 100 | 0.9% | 2.1 | 1.4% | 3.3 | 1.0% |
| Seas / Space | 13 | 462 | 4.1% | 0.3 | 0.2% | 0.3 | 0.1% |
| World | 301 | 11404 | 100.0% | 144 | 100.0% | 337 | 100.0% |

Note: some percentages may not add up to 100 due to rounding.
Source: Swiss Re Institute

## North America

The 2017 North Atlantic hurricane season was one of the most active and destructive of recent years.

In North America, insured losses from disaster events were USD 119.1 billion in 2017, the highest of all regions. Most of the losses came from hurricanes. The 2017 North Atlantic hurricane season produced 17 named storms (15 in 2016), 10 of which became hurricanes (seven in 2016) and six were "major" (category 3 or stronger on the Saffir-Simpson scale[2]). After 12 years without a major storm landfall in the US, a record three category 4+ hurricanes came ashore.[3]

Hurricane Harvey produced record levels of rainfall for a tropical cyclone, leading to devastating floods.

On 25 August 2017, Harvey became the first major hurricane to make landfall in US since Wilma in 2005. While the winds weakened considerably after landfall, Harvey stalled along the Texas coast, unleashing an unprecedented amount of accumulated rain, which caused catastrophic flooding in some of the most populated areas of the Gulf Coast, including Houston. Total economic losses from Harvey were around USD 85 billion, and insured losses were USD 30 billion. The level of rainfall that Harvey brought was the highest ever to have come with a tropical cyclone in the US since reliable records began in the 1880s.[4] About 200000 homes in Texas were inundated and 500000 vehicles damaged. Around 80% of homes in the Houston metropolitan area are uninsured against flood risk, pointing to a large protection gap.

The experience reaffirms the vulnerability of the Houston metropolitan area to flooding.

Harvey was the third major inland flood event to hit the Houston metropolitan area in as many years. In each of 2016 and 2015, a major thunderstorm brought heavy rains and flooding. The regularity of flooding highlights the vulnerability of Houston to water inundation. The metropolitan area has expanded massively in the past 15 years, with the suburban sprawl extending onto flood plains that are prone to

[2] The Saffir-Simpson scale rates hurricane intensity from category 1 to 5, according to sustained wind speeds in a hurricane. Storms rated category 3 and above are considered major hurricanes. See https://www.nhc.noaa.gov/aboutsshws.php
[3] Hurricane Sandy in 2012 made landfall as a category 1 storm.
[4] E.S. Blake, D.A. Zelinsky, *National Hurricane Center Tropical Cyclone Report – Hurricane Harvey*, National Oceanic and Atmospheric Administration, 23 January 2018, 29018https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf

flash floods when precipitation is extreme. The ever-expanding area of paved surfaces means rainwater runs along the surface rather than being absorbed into the ground.

Hurricane Irma and Maria wreaked havoc in the Caribbean and Puerto Rico.

Not long after Harvey came Hurricane Irma which, when at category 5 strength for more than three days, inflicted massive destruction across many Caribbean islands (see section on *Latin America and Caribbean*). When the hurricane made US landfall on 10 September at category 3 intensity, compounded flooding from the combination of strong winds, storm surges and extreme precipitation hit parts of western Florida and South Carolina. The storm missed the major population centres of Miami and Tampa. Economic losses from Irma were USD 67 billion, of which USD 30 billion were insured. Two weeks later in September came Hurricane Maria which again struck the Caribbean islands and also Puerto Rico, the unincorporated territory of the US. It was the strongest hurricane to hit Puerto Rico since 1928 and it crippled the island's infrastructure including the water system, power grid, transport and communication networks, and energy facilities. In February 2018, more than three months after the event, Puerto Rico was still functioning on emergency power.[5] Overall insured losses from Maria were estimated to be USD 32 billion.

Tornado activity and insured losses from severe convective storms were above average last year.

Other than hurricanes, 2017 was also a busy year in terms of tornado activity. According to a preliminary count from the Storm Prediction Centre of the National Oceanic and Atmospheric Administration (NOAA), there were 1522 tornadoes in the US in 2017, above the annual average of 1221 of the Doppler radar era. Insured losses from tornado outbreaks and thunderstorms (severe convective storms) reached an estimated USD 19 billion, similar to 2016 (USD 20 billion), but higher than the previous 10-year annual average of USD 15 billion. There were six independent severe convective storms that each caused losses of USD 1 billion or more. The largest was a hailstorm in Denver, Colorado in the spring, resulting in insured losses of USD 2.5 billion. There were also 32 thunderstorms in the US, less than in 2016 (37), but more than the average of the previous 10-years (26).

2017 will pass as the costliest year for wildfire losses ever, globally.

In October and December, there were separate wildfire outbreaks that led to record losses across northern and southern California, respectively. (*See California burning: growing exposure yields record wildfire losses*). The Tubbs fire in the Sonoma and Napa counties destroyed the most number of structures and caused USD 7.7 billion in insured losses, making it the costliest wildfire ever on *sigma* records. There were wildfires in Canada too in 2017. In July, more than 1300 fires in British Columbia burned more than 1 200 000 hectares of land, making 2017 the province's worst wildfire season on record in terms of areas scorched.[6] It was a record fire year globally too: at more than USD 14 billion, insured losses from wildfire events around the world were the highest ever.

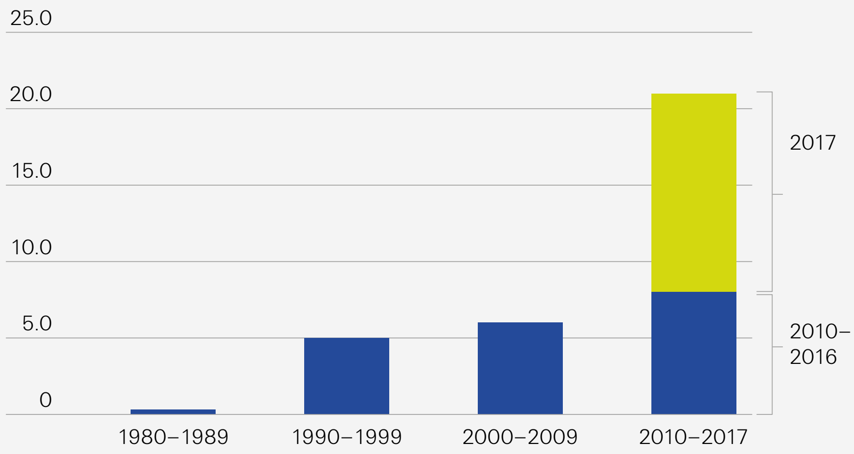
5 The text for this report was finalised in late February 2018.

6 *BC Wildfire Service*, British Columbia, 4 February 2018, see http://bcfireinfo.for.gov.bc.ca/hprScripts/WildfireNews/Statistics.asp

**California burning: growing exposure yields record wildfire losses**
Worldwide losses from wildfire events have grown over recent decades. This is true for North America too, where most wildfire losses occur. Figure 5 illustrates the significant increase in wildfire-related insured losses in the US and Canada since 1980, and also the extent of the record-breaking losses in 2017. Changing climate conditions and increased exposures likely explain this observed trend.

**Figure 5**
Insured losses from wildfires in the US and Canada since 1980 by decade (USD billion), at 2017 prices

Insured losses from wildfires in 2017 highest ever




Source: Swiss Re Institute

There was major outbreak of forest fires in northern California in October.

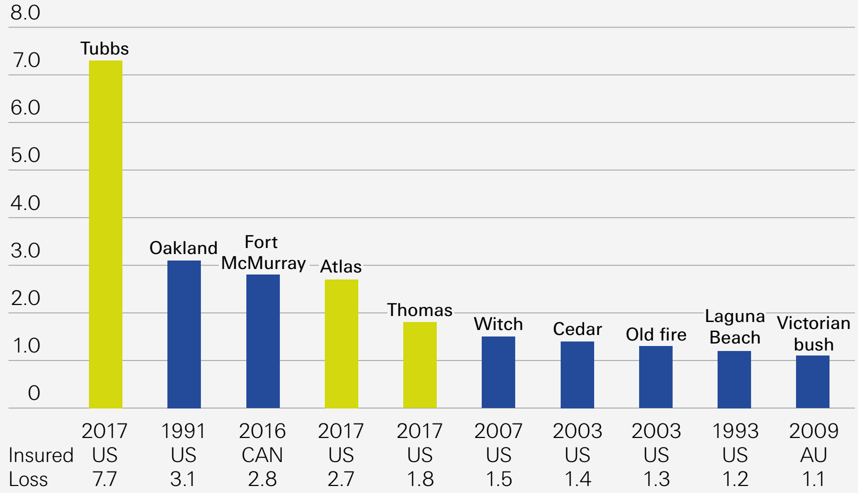
In 2017, there were two record-setting wildfire outbreaks in California: one in northern California in October, and the other in southern California in December. The events resulted in combined insured losses of close to USD 13 billion. First, in October 250 wildfires broke out across eight counties in northern California, burning nearly 100 000 hectares in the valleys north of San Francisco and destroying approximately 8900 structures.[7] This outbreak included the Tubbs Fire, which burned more than 15 000 hectares of forest and destroyed more than 5600 structures, making it the most destructive wildfire in California ever in terms of number of structures destroyed.[8] The outbreak also included the Atlas and Mendocino Lake Complex Fires, which covered 20 000 and 15 000 hectares, respectively, and likewise caused widespread damage. Vineyards in Napa and Sonoma Counties were also burned, and some winemakers will face reduced yields for years to come.

The Tubbs fire in October 2017 was the costliest wildfire event ever.

As of January 2018, the total insured losses from the October firestorm in Northern California were estimated at more than USD 10.9 billion, the highest ever recorded. The Tubbs Fire alone is estimated to have resulted in USD 7.7 billion of those losses, becoming the costliest wildfire event in the US ever.[9] According to *sigma* records, three of the five largest-ever insured loss totals from wildfire events across the world occurred in the 2017 outbreaks in California (see Figure 6).

[7] *California Statewide Fire Summary*, Cal Fire, 30 October 2017, http://calfire.ca.gov/communications/communications_StatewideFireSummary
[8] *Top 20 most Destructive Wildfires*, Cal Fire, 12 January 2018, http://www.fire.ca.gov/communications/downloads/fact_sheets/Top20_Destruction.pdf
[9] See PCS Estimates of Insured Property Loss, https://www.verisk.com/insurance/products/property-claim-services/estimates-of-insured-property-loss/

**Figure 6**
Top 10 insured losses from wildfires, worldwide (USD billion), at 2017 prices




Source: Swiss Re Institute

Tubbs: the insurance industry´s costliest fire event ever

In terms of area burned, the Thomas fire in December 2017 is the largest ever to have occurred in California.

In December, a second round of wildfires broke out, this time in southern California, burning over 124 000 hectares. This outbreak included the Thomas Fire in Ventura and Santa Barbara Counties, which remained active until January 2018 and burned 114 000 hectares, the largest wildfire in California in terms of area impacted.[10] The number of structures destroyed in the southern California outbreak was fewer than in the north, and the insured losses were also significantly lower. To date, the insured loss estimate estimate of the three most damaging wildfires in the southern California outbreak (Thomas, Creek and Lilac Fires) stands at USD 2.1 billion, but the exact figure is still unfolding.

Prolonged dry conditions created the perfect setting for major fires.

The exact cause of many of the 2017 California fires remains unknown, but the state´s climatic and hydrologic conditions provided the perfect setting for inferno. After a multi-year drought from December 2011 through late 2016, the state finally received much-needed precipitation in the winter of 2016/17, with northern California experiencing its wettest winter ever.[11] The wet winter had bearing on the voracity of the wildfires later in the year. The heavy rains and snow prompted quick regrowth of bushes, shrubs and grasses. However, once the snowpack melted in early spring, the moist soils quickly dried with the onset of what turned out to be California's hottest summer on record.[12] The dry surface conditions intensified throughout the summer, drying out the dense vegetation that had grown as a result of the winter moisture. This, combined with strong autumn gusts like the Santa Ana and Diablo winds which push warm/dry air into California from the east, generated ample fuel for the wildfires that followed.

[10] *Thomas Fire*, Cal Fire, 12 January 2018, http://www.fire.ca.gov/current_incidents/incidentdetails/Index/1922

[11] *Northern California Northern California Just Surpassed the Wettest Year on Record*, Scripps Institute of Research Oceanography, 13 April 2017, https://scripps.ucsd.edu/news/northern-california-just-surpassed-wettest-year-record. The rains allowed the state's reservoirs to refill. The precipitation, however, also brought devastating consequences, starting with extensive flooding and mudslides in the early months of 2017.

[12] D. Swain, "2017 hottest summer in California history," *Climate Signals beta*, 9 September 2017, http://www.climatesignals.org/headlines/2017-hottest-summer-california-history

## Why are losses rising?

Fire seasons have been observed to last longer…

Large wildfire losses in the western US and Canada in recent years have raised questions about observed trends in frequency and intensity. One significant trend is longer wildfire seasons, defined as the time between the first discovery and last control of a wildfire. On average, wildfire seasons in 2003–2012 were around 84 days longer than in 1973–1982.[13] The extension corresponds with longer burning times of large fires: between 1973 and 1982, on average large fires burned for six days before being contained; in 2003–2012, the average large fire burn time was more than 50 days.

… and large fires have been happening more frequently.

In addition, large wildfire (>400 hectares) events have become more frequent. From 1973 to 2012, approximately 20 additional large wildfires occurred each decade in the western US on land controlled by the US Forest Service, National Park Service and Bureau of Indian Affairs.[14] This has led to an increase in the area burned by wildfires each year, as observed in data for 1983 to 2015.[15] It is important to note, however, that the magnitude of the trends presented here are based on spatial averages over the western US, and regional trends may differ slightly.

Increased development in the wildland-urban interface has put more people and properties at risk.

In North America, the observed increase in wildfire risk is widely understood to be due to changing exposures and climate conditions. With respect to exposures, property in the wildland-urban interface (WUI), that is regions adjacent to or within undeveloped natural areas and vegetative fuels, is particularly susceptible to wildfire hazard given the proximity to the forest and wildfire embers.[16] Since 1990, 60% of new homes in the US have been built in the WUI, meaning more value-at-risk in regions where wildfire suppression is challenging. The number of homes in the WUI rose by 42% between 1990 and 2010, from 30.8 million to 43.8 million units.

**Table 4**
Expansion of the wildland-urban interface in the US, 1990 to 2010

| | Geographic extent (square km) | Total number of housing units (millions) | Population (millions) |
|---|---|---|---|
| **1990** | 580 000 | 30.8 | 73 |
| **2000** | 690 000 | 37 | 86 |
| **2010** | 770 000 | 43.8 | 99 |

Source: The 2010 Wildland-Urban Interface of the Conterminous United States, US Department of Agriculture, June 2015, https://www.fs.fed.us/nrs/pubs/rmap/rmap_nrs8.pdf

[13] A LeRoy Westerling, "Increasing western US forest wildfire activity: sensitivity to changes in the timing of spring", *The Royal Society Publishing*, 23 May 2016, http://rstb.royalsocietypublishing.org/content/371/1696/20150178
[14] Ibid.
[15] *Climate Change Indicators: Wildfires*, US Environmental Protection Agency, April 2016, https://www.epa.gov/climate-indicators/climate-change-indicators-wildfires
[16] *Wildfire, Wildlands, and People: Understanding and Preparing for Wildfire in the Wildland Urban Interface*, US Department of Agriculture, January 2013, https://www.fs.fed.us/openspace/fote/reports/GTR-299.pdf

At the same time, timber harvesting and other factors have led to greater accumulations of flammable biomass.

Factors driving development in the WUI are population growth, housing preferences and demand for vacation-homes. Another factor contributing to increased wildfire risk is changes in timber harvesting and grazing practices, which have led to greater accumulations of flammable biomass. Also, changes in insect infestation including beetle activity have accelerated the drying of trees, making them more flammable.

A warming climate is expected to increase wildfire risk even further.

Projected changes in climate, including warmer temperatures and drier surface conditions, are expected to continue to increase the frequency and severity of large wildfires. The western US and Canada tend to have cool-and-wet winters and warm- and-dry summers. The overall warming in recent years has reduced the accumulation of snowpack during the cool-and-wet winters, and brought forward the onset of spring. In turn, this has led to extension of the warm-and-dry summers in which wildfires can start and spread.

The human component in wildfire ignition makes modelling wildfire risk challenging.

Wildfire risk is included in standard homeowner's insurance policies. Scientists have a good understanding of the environmental conditions conducive to wildfire, but modelling wildfire risk is challenging given the unpredictability of the role humans play in both initiating and suppressing wildfire activity. And, once ignited, the spread and ease of containing a fire are influenced by a number of environmental conditions including wind, temperature and humidity. Irrespective of such challenges in pricing the risk for insurance purposes, the very large and growing scale of wildfire losses highlights the importance of increasing resilience through planning, building practices and exposure reduction.

# Hurricane Andrew: how a single storm changed the global re/insurance industry

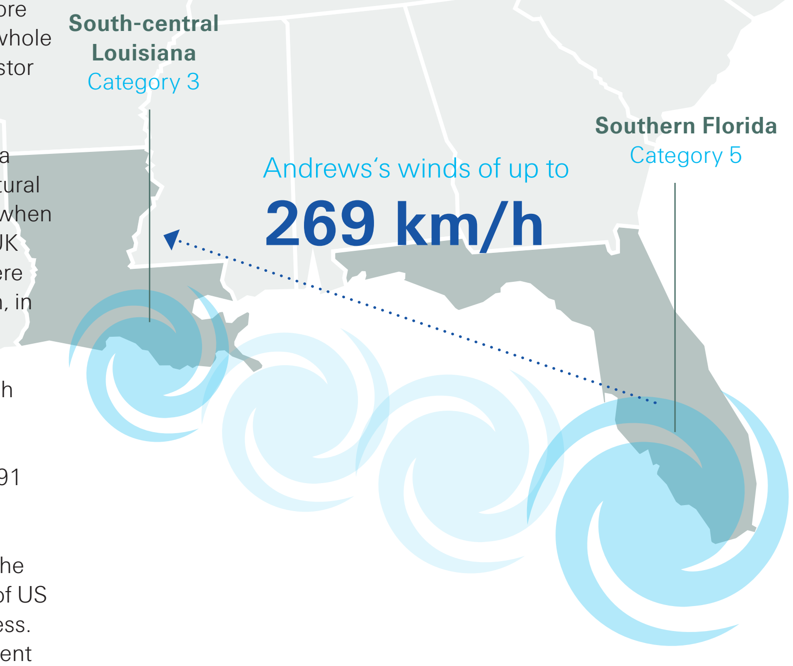
sigma 50 YEARS

## USD 27 billion insured losses (in 2017 prices)

Hurricane Andrew in 1992 remains a watershed event in the development of the re/insurance industry. Even though the insurance losses from subsequent hurricanes like Katrina in 2005 have been much larger (see the Figure below), the losses from Hurricane Andrew far exceeded the then-estimated maximum potential cost that a catastrophe might inflict. The scale of Andrew's losses prompted fundamental changes in the operations of the re/insurance sector. Significantly, the industry embraced scientific modelling, and the global diversification of reinsurers increased. At the same time, market fragmentation increased with the emergence of offshore reinsurer start-ups, and the securitization of catastrophe risks. The market as a whole became more fluid and more stable, due to lower barriers to entry for fresh investor capital and convergence with capital markets.

*sigma* has been collecting information on disaster events for 50 years, building a comprehensive data series that has shown increasing insurance losses from natural and man-made catastrophes over time. An important milestone came in 1987, when insured losses from a single event – the Great Storm in October impacting the UK and France – exceeded USD 1 billion (in 1987 prices) for the first time ever. There was at least one USD 1 billion loss event in each of the next few years. And then, in August 1992, came Hurricane Andrew.

Hurricane Andrew struck southern Florida at Category 5 intensity and later south central Louisiana at Category 3. Andrew's winds of up to 269 km/h and storm surge resulted in 1992 insured losses of USD 16 billion (USD 27 billion in 2017 prices). That was almost three times the USD-5.6-billion insured loss total in 1991 from Typhoon Mirelle in Japan, the previous most costly event. The Andrew experience demonstrated the extent of financial losses that can result in coastal regions of growing population density and development which are exposed to the natural elements. The huge insurance losses from Andrew accounted for 9.5% of US industry capital in 1992, and drove a few single-state P&C insurers out of business. However, Andrew had much further-reaching impacts in terms of the development of the re/insurance industry overall.




### Fundamental changes to the global re/insurance market

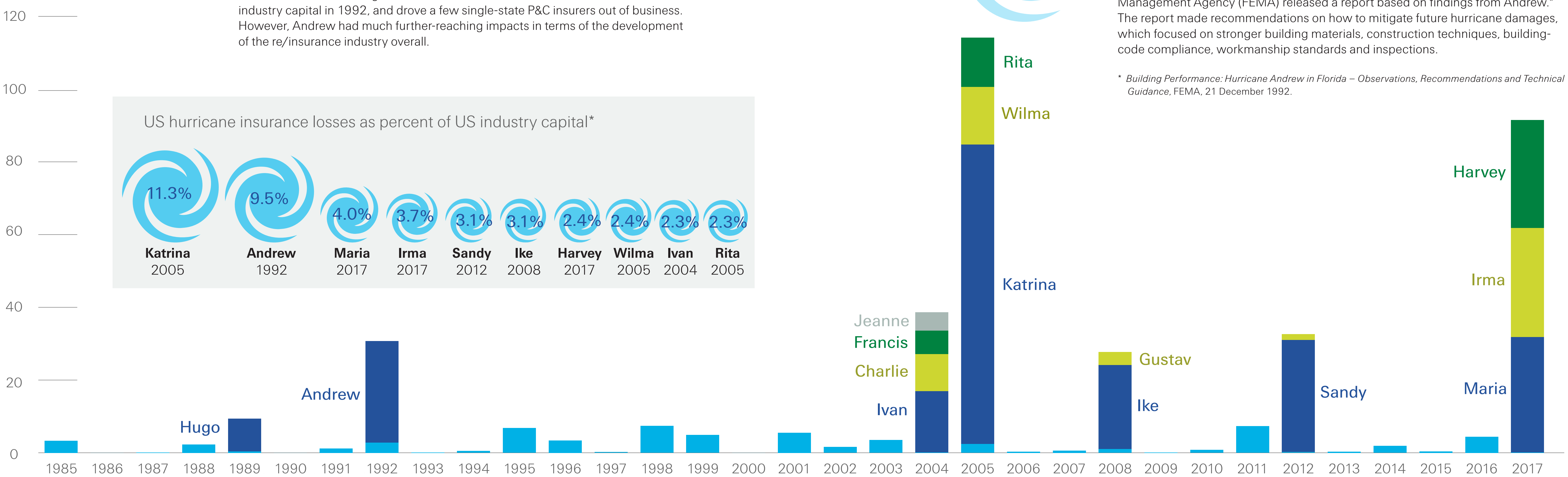
**Andrew kick-started the development of cat modelling.** The first cat models for hurricane risk assessment were developed in the late 1980s, but had not been widely used. That changed after Andrew, which validated the credibility of the models and led to their widespread adoption. Ongoing data collection and the exponential growth of computing power has further enabled quantum leaps in the sophistication of cat modeling. Rating agencies' use of cat models as an input to assess insurers' financial strength has further promoted their proliferation. Today, even solvency regulation incorporates the use of cat models.

**The securitisation of catastrophe risks (eg, cat bonds) started in the aftermath of Andrew**, driven by the motivation to bring more risk-bearing capacity to the catastrophe reinsurance market. Additional capacity was important because of a shortage of reinsurance capital due to multiple factors, including the Lloyd's crisis of the late 1980s and early 1990s, and skyrocketing claims from US asbestos and environmental liabilities. A number of offshore start-ups were formed in Bermuda and since Andrew, offshore capital has been a significant source of reinsurance capacity, especially for US-cat risks.

**Since Andrew, the state of Florida has become a laboratory for disaster risk financing, mitigation and emergency management.** After Andrew, private sector capital withdrew from the market so the state government expanded its role as insurer of last resort. Florida set up new and enhanced primary insurance facilities, and created a mandatory public catastrophe reinsurance fund, the Florida Hurricane Catastrophe Fund (FHCF), to provide affordable coverage for home- and business owners. The state authorities also improved hurricane preparedness, emergency management and disaster recovery. And in December 1992, the Federal Emergency Management Agency (FEMA) released a report based on findings from Andrew.* The report made recommendations on how to mitigate future hurricane damages, which focused on stronger building materials, construction techniques, building-code compliance, workmanship standards and inspections.

* *Building Performance: Hurricane Andrew in Florida – Observations, Recommendations and Technical Guidance*, FEMA, 21 December 1992.

Insurance losses from hurricanes in USD billion (in 2017 prices)




*Note: the insurance loss figures in this figure do not include payouts from the National Flood Insurance Program (NFIP) in the US.
Source: Swiss Re Institute

## Europe

In Europe, insured losses from natural catastrophes and man-made disasters were USD 12 billion in 2017.

Economic losses from catastrophe events in Europe in 2017 were USD 23.7 billion, of which USD 12 billion were covered by the insurance industry. Most of the losses came in periods of weather extremes, including a series of windstorms and a cold snap early in the year, and drought conditions later. In late spring, a cold spell brought frost damage to crops in many countries. The crops had bloomed prematurely due to an unseasonably warm winter. Economic losses were estimated to be USD 4 billion, of which USD 0.9 billion were insured. The vegetation period has frequently started early in past years, and this can inflate crop losses when frost conditions set in.

**Frost from late spring cold snap bites into European agriculture produce**

A cold snap in late spring caused severe frost damage to European agriculture…

It looked like 2017 was going to be a good year for Europe's farmers, with warmer-than-usual temperatures in February and March sparking early budding and fast crop growth. In mid-April, however, the weather changed, dramatically. A low pressure system from the north brought cold polar air over Central and Eastern Europe, and then to the Iberian Peninsula.[17] The cold wave eventually hit most of Europe, with temperatures dropping to below zero degrees Celsius overnight. The low pressure system also brought snow and ground frost.[18]

…and economic losses of at least USD 4 billion, mostly uninsured.

The ground frost in particular proved devastating. Many farmers claim the 2017 cold snap was the worst they have ever experienced. Agricultural economic losses across Europe were at least USD 4 billion, of which 22% were insured. France and Italy reported the highest losses, mainly from damage to vineyards. Frost is an ever-present and major hazard for vineyards. In France, grape yields fell to 60-year lows, with around 60% of wine-growing areas like Bordeaux hit by the freeze.[19] Farmers attempted to protect their vineyards by installing heat-producing torches to warm the plants, and fans and sprinkler systems too. But the measures only proved effective in areas where the temperature dropped slightly below zero, and where there were no frosty winds.

Winemakers and fruit farmers were particularly hard hit.

Fruit farmers were also hit hard. In Germany, for example, frost damage led to an approximately 50% yield reduction from apple orchards.[20] The magnitude of losses forced some farmers into debt and state-backed disaster relief funds were used to support those affected. It was the first time in Germany that frost has received recognition as a natural disaster "variable" in this way.[21]

*Climate change expected to stimulate early plant development*

The magnitude of the losses was influenced by the mild winter, which caused crops to bud early.

From a meteorological perspective, the cold snap in late spring 2017 was not unusual. On average, such snaps occur every two to four years, depending on region and altitude.[22] What was abnormal were the warmer temperatures in February and March. These caused crops to bloom prematurely, with the vegetation period for fruit trees and vineyards starting around 14 days earlier than usual. [23] The sudden drop in

[17] *Ungewöhnliche Kälte / Starkschneefall Mitteleuropa, Alpen, Balkan, Wettergefahren-Frühwarnung*, Institut für Meterologie und Klimaforschung, May 2017, http://www.wettergefahren-fruehwarnung.de/Ereignis/20170423_e.html

[18] *Cold wave hits Europe*, Vencore Weather, April 2017, https://www.vencoreweather.com/blog/2017/4/18/1240-pm-cold-wave-hits-europe

[19] "Bordeaux Winemakers Optimistic on '17 Quality after frost damage", *Bloomberg*, October 2017, https://www.bloomberg.com/news/articles/2017-10-21/bordeaux-winemakers-optimistic-on-17-quality-after-frost-damage

[20] Aprilfröste dezimieren Obsternte, *Deutscher Bauernverband*, August 2017. http://www.bauernverband.de/?redid=801452

[21] *Staatshilfe für massive Ernteausfälle,* Main Post, 19 September 2017, http://m.mainpost.de/ueberregional/bayern/Franken-Landwirtschaftsminister-Versicherungen-Weingaertner;art16683,9751071

[22] *Jahrhundertchronik 1900–1999,* Wetterzentrale, April 2003, http://old.wetterzentrale.de/cgi-bin/webbbs/wzconfig1.pl?noframes;read=93

[23] *Extreme Wettervielfalt 2017: 250 Mill. Euro Gesamtschaden in der Landwirtschaft*, Die Österreichische Hagelversicherung, September 2017, https://www.hagel.at/site/index.cfm?objectid=685A917D-5056-A52F-54948A1BBA5ACA5F&refid=2C81258A-3005-4277-CFC40E405708392F

A warming climate is likely to increase the frequency of extreme weather conditions and complicate the business of growing crops.

temperatures after this earlier start meant that crops were hit by frost at their most critical and vulnerable growth phase, which exacerbated the damage.

Climate change will likely lead to more frequent warm winters and earlier springs. With this will come earlier plant development, an extension of the growing season, and early crop growth that is ever-more vulnerable to cold snaps, because the frequency and severity of late spring frost events has not changed much over time.[24] The warmer conditions, especially during winter, entail another challenge for agriculture, in that they affect the proliferation of invasive species and diseases. Additionally, weather events like drought, heavy rains and storms may become more frequent and severe due to changing climate, further impacting farmers' livelihoods.

Drought and high temperatures triggered severe forest fires in Portugal…

From cold to hot, Europe experienced a heat wave in the summer. In Portugal, the heat and strong winds created conditions for uncontrollable, and ultimately deadly, forest fires. In June, 65 people died in one event, most trapped in their cars when fires surrounded and swept across a stretch of road. In October, another round of wildfires in central and northern regions broke out in more populated regions.

…resulting in insured losses of USD 0.3 billion, the highest ever in the country.

With the summer heat and large areas where flammable eucalyptus and pine trees grow, Portugal is prone to wildfires and has experienced devastating outbreaks many times before. But 2017 was an exceptional year: the number of hectares burned from the beginning of the year through end October was 53 times more than the annual average of the previous 10 years.[25] The direct cause of the outbreaks remains unknown, but with average temperatures 3°C above normal, October was the hottest since 1931 and at end of that month, extreme drought conditions had extended across 75% of the entire country.[26] The October fires alone led to insured losses of USD 0.3 billion, the most ever in Portugal.

## Asia

The Yangtze River basin flood in China was the costliest disaster event in Asia in 2017.

Economic losses from disaster events in Asia were an estimated USD 31 billion in 2017, of which USD 5 billion were covered by insurance. A majority of the losses resulted from flood events. In China, heavy rains caused the Yangtze River to flood again, with pluvial and river flooding across 11 provinces inundating more than 400 000 homes. The economic losses were estimated to be USD 6 billion, the largest from a single event in the year in Asia. With low insurance penetration, however, insured losses were negligible.

There were also severe, deadly floods in Nepal, India and Bangladesh.

The monsoon is an essential part of Asia's ecosystem and agriculture, but the rains also bring seasonal flooding. The monsoon rains in 2017 were very heavy and fell for long durations. India and neighbouring Nepal and Bangladesh bore the brunt of the season's associated losses. Economic losses from a series of flood events in Bihar, Assam, West Bengal and other states in India were around USD 2.5 billion, while Nepal suffered USD 0.6 billion of losses in the Terai region. Approximately 200 000 houses in Nepal were damaged or destroyed due to flooding, and 134 people died. Crop losses, including of the main staple food, rice, were severe. The flooding was made worse by unplanned development in areas of high population density. Physical construction interferes with surface water flows and causes drainage congestion and waterlogging.

[24] Climate change increases risk of spring frost at higher elevations, *Institute for Snow and Avalanche Research*, September 2017, https://www.slf.ch/en/news/2017/09/spring-frost.html

[25] *Relatório Provisório de Incêndios Florestais – 2017*, Instituto da Conservação de natureza e das Florestas, 3 October 2017, http://www2.icnf.pt/portal/florestas/dfci/Resource/doc/rel/2017/10-rel-prov-1jan-31out-2017.pdf

[26] *Balanço Climático Preliminar do Ano 2017, Portugal Continental*, Instituto Português de Mar e da Atmosfera, 29 December 2017, http://www.ipma.pt/resources.www/docs/im.publicacoes/edicoes.online/20171229/fVhUCTqvyGjAJEZEUlwS/cli_20170101_20171229_pcl_aa_co_pt.pdf

## Latin America and the Caribbean

Insured losses in Latin America were more than USD 5 billion in 2017.

In Latin America and the Caribbean, natural catastrophes and man-made disasters caused economic losses of USD 31.6 billion in 2017. Insured losses were more than USD 5 billion. The main drivers of the losses were hurricanes and earthquakes. Floods and wildfires also affected the region.

Hurricanes Irma and Maria brought devastation to the Caribbean…

In September, Hurricane Irma made landfall on five of the Caribbean islands at category 5 intensity, before heading to Florida. It was the strongest storm of the 2017 season, bringing mass destruction across the Lesser Antilles, Saint Martin and Saint Barthélemy, the British and US Virgin Islands. Private homes, businesses, agriculture, natural resources and tourist resorts were severely impacted. Two weeks later, Hurricane Maria was the first category 5 on record to make landfall in Dominica. The 2017 hurricane season will pass down as the worst in history in the Caribbean. The extent of damage across the region reflects the degree of preparedness and level of development in the impacted islands. In many, a drop in the level of commercial activity and also in living conditions may continue for a long while yet. Hurricane Irma was the costliest ever for the Caribbean.

…and there were two strong earthquakes in Mexico.

The Tehuantepec and Puebla earthquakes were among the strongest ever recorded in Mexico. The Mw 8.1 quake in Tehuantepec on 7 September was felt across central and southern Mexico, and 96 people died in the event. The Mw 7.1 shake of 19 September (Puebla) produced strong ground motions in major cities in central Mexico, including the capital. Many buildings collapsed and 369 people died.

### Mexico earthquakes in 2017: building codes do work

Implementation of anti-seismic building codes greatly reduces the vulnerability of homes and other structures to earthquake risk.

The extent of damage to and collapse of buildings after two powerful earthquakes in Mexico last year confirm that structures built in line with anti-seismic codes better withstand ground-shake events. Even so, many people and businesses in Mexico remain heavily exposed to building damage and collapse, and the potentially large financial losses associated with earthquake risk. The September earthquakes are a case in point: insured losses from the two events were USD 1.6 billion. But that was just a fraction of the economic losses of USD 12 billion.

In Chiapas, the earthquake destroyed many houses because they did not conform to the latest building codes.

On 7 September 2017, Mexico experienced its largest-ever earthquake on record, when a magnitude 8.1 quake struck the Gulf of Tehuantepec off the southern coastline. Less than two weeks later, a separate earthquake of magnitude 7.1 hit central Mexico at the border between Puebla and Morelos, producing ground motion in Mexico City, 133 km away. The first earthquake struck scarcely populated coastal regions of the Chiapas and Oaxaca states, but tremors were widely felt across the central and southern Mexico. Around 96 people lost their lives and more than 140 000 houses were damaged or destroyed. This was due to the sheer magnitude of the earthquake and the vulnerability of local housing stock, much of which does not conform to the building code guidelines of 1987.

In Mexico City, however, new structures built according the guidelines stayed standing.

The Puebla/Morelos earthquake on 19 September claimed 369 lives. Around 2000 buildings sustained moderate to severe damage, and 80 buildings in Mexico City and nearby urban centers were completely destroyed. Most of the buildings that collapsed had been built before 1987, when new anti-seismic provisions were introduced. The buildings that did fall down or were damaged revealed deficient structural configuration and non-adherence to the updated building codes. Mexico City remains highly exposed to earthquake hazard and the city mostly sits on soft soils which amplify the intensity of ground motions.[27, 28] As a result, ground shakes

[27] F. Galvis, E. Miranda et al., *Preliminary Statistics of Collapsed Buildings in Mexico City in the September 19, 2017 Puebla-Morelos Earthquake*, 19 Septmeber 2017, Stanford University, http://www.learningfromearthquakes.org/2017-09-19-puebla-mexico/images/2017_09_19_Puebla_Mexico/pdfs/Preliminary_Report_Mexico2017_v7.pdf

[28] D. Jacobsen, R. Stein, "Mexico City building collapses were preventable-and so will be ours", *Temblor*, 6 October 2017, http://temblor.net/earthquake-insights/the-lesson-to-be-learned-from-mexico-citys-building-collapses-5405/

can happen, even when the epicenter is far away. For example, the Michoacán earthquake in 1985 struck more than 300 km away, but still resulted in mass devastation in the capital.

## Oceania

Cyclone Debbie was the biggest disaster event in the Oceania region.

Disaster events in Oceania triggered insured losses of USD 2.1 billion in 2017. Most losses came from Cyclone Debbie in March/April which brought wind, wind-driven rainwater and storm surge damage to southeast Queensland and northeast New South Wales. Insured losses were USD 1.3 billion. Later the North island of New Zealand suffered flooding due to an extratropical cyclone, which also carried moisture from remnants of Cyclone Debbie. Insured losses were USD 0.1 billion. A separate major event was a hailstorm in Sydney in February, which caused insured losses of USD 0.4 billion.

**Cyclone Debbie — a claims management perspective**

Damage from water ingress accounts for a significant portion of the overall losses that Cyclone Debbie caused.

Tropical cyclones in Australia are nothing new. But Cyclone Debbie, which made landfall in northern Queensland on 28 March 2017, brought some new insights of interest for risk managers. As a Category 4 cyclone, with gusts of up to 263 km/h recorded on the offshore islands, expectations were that Cyclone Debbie would result in a significant wind damage. When it crossed the coast in Queensland, however, Debbie weakened but maintained a low translational (or forward) speed. This meant the buildings in its path were subjected to cyclone-strength winds and wind-driven rain for more than 12 hours. The resultant claims costs were significant, even in areas where wind speeds were low, and it eventually became clear that water ingress would account for a significant part of the overall damage. The initial damage assessments did not pick up the internal water damage to buildings. Rather, the full extent of insurance losses took many months to develop.

A number of factors led to post-event loss amplification.

Increased costs and complexities with respect to loss management and reinstatement were also part of the Cyclone Debbie story on Hamilton Island and the Whitsundays. Some building stock there is old and in certain cases, had pre-existing damage that was made worse by Debbie. This led to cost increases around statutory compliance upgrades, and also mould and asbestos removal and disposal. On Hamilton Island, reinstatement works have been hindered by access issues, resulting in delays in the completion of loss assessments and potentially increasing claims costs. The domino effect has been delays in appointing contractors to undertake repairs and getting materials and machinery onto the island to progress works. The claims experience after Cyclone Debbie highlights that even well-known risks can bring new learnings and that factors that have not been revealed by previous loss experiences may not be fully captured in current loss models.

## Africa

In Africa, around 3000 people died in disaster events in 2017.

In Africa, natural and man-made disasters claimed around 3000 lives and caused economic losses of more than USD 2.9 billion in 2017. Insured losses were USD 0.8 billion, mostly relating to claims from wildfires, storms and other severe weather events, but also to accidents at oil and gas facilities. In January, strong winds fuelled forest fires in South Africa, resulting in insured losses of USD 0.2 billion, the highest ever wildfire loss recorded in the country. Meanwhile a winter storm in Cape Town at the same time resulted in insured losses of USD 0.1 billion. Later in the year, heavy rains in Sierra Leone triggered flooding, a massive landslide and debris flow into the Babadorie River Valley. 1141 people died in the disaster.

# HIM: an unprecedented hurricane cluster event?

## The Harvey, Irma and Maria trilogy

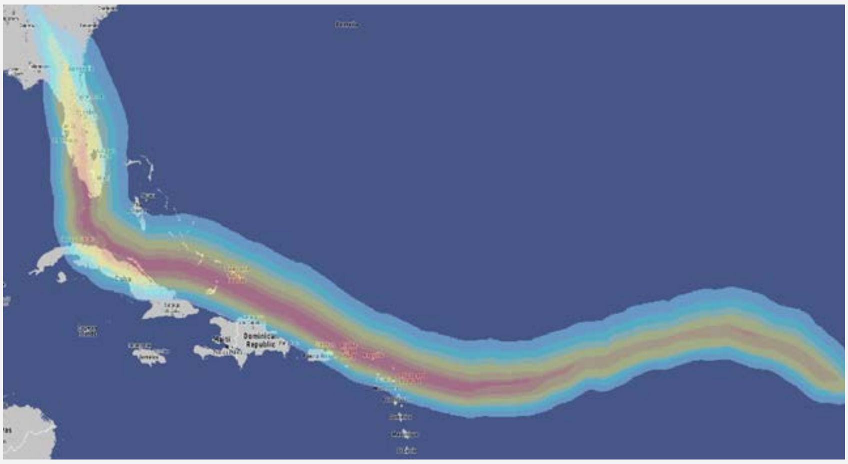
Three destructive storms in quick succession: Hurricanes Harvey…

The 2017 Atlantic hurricane season featured a series of major storms. The most destructive were three that came in quick succession: Harvey, Irma and Maria (HIM). In mid-August, after forming east of the Lesser Antilles, Hurricane Harvey travelled through the southern Caribbean. It took a while to develop proper circulation around its core but when it did, it went from being a weak cluster of thunderstorm clouds to a full-blown category 4 hurricane on the Saffir-Simpson scale within 48 hours. It made landfall near Rockport, Texas at this intensity, on 25 August 2017, the first major hurricane to make landfall on the US for 12-years (since Hurricane Wilma in 2005).[29]

…Irma…

As the relentless downpours that came with Harvey were flooding the metropolitan Houston area and other parts of Texas, the nascent Hurricane Irma started its journey across the Atlantic towards Florida. After hovering at around category 2/3 intensity for a few days, Irma intensified rapidly over warmer sea surface temperatures, attaining the highest category 5 intensity on 4 September, at which it stayed for more than three full days. Irma unleashed the brutal fury and destructive force of its eyewall directly over Barbuda, St. Martin/St. Barthélemy, Anguilla and the British and US Virgin Islands. The storm started to weaken slightly after passing the Turks & Caicos Islands but still cast devastation across the northern shores of Cuba. The interaction with Cuba's mountains weakened the storm further: Irma made its final landfall on the west Florida coast at category 3 intensity on 10 September. It had been on course towards Miami at this intensity, but changed direction and veered towards western Florida instead. If the storm had hit Miami at category 3, market estimates at the time were foreseeing insured losses of around USD 100 billion. Never before has the insurance market been tested to absorb a loss of that size from a single event.

**Figure 7**
Hurricane Irma wind footprint across the Caribbean from Swiss Re CatNet®



Light blue: >25m/s; yellow: >40m/s; dark red: >70m/s (3-second peak gusts)
Track source: National Oceanic and Atmospheric Administration; Map source: ESRI, Google

[29] According to the National Hurricane Centers HURicane DATabase (HURDAT), prior to Wilma, the longest such periods were two 5-year periods at the beginning of the 20th century.

…and Maria…

Two weeks later, Hurricane Maria passed through the Caribbean islands. Relief efforts for those affected by Irma had just started, but then had to be suspended. Maria developed from a category 1 into a category 5 hurricane within 15 hours, one of the fastest intensifying storms on record. To make matters worse, this happened just before the storm made landfall on Dominica, leaving very little time for preparations. Continuing north-westwards, Hurricane Maria maintained its intensity when its eye brushed the southern US Virgin Island of St. Croix. Roughly 30 hours after leaving Dominica, it made landfall on Puerto Rico's south-eastern coast at only slightly weaker category 4 intensity. Steadily weakening after passing Puerto Rico, Maria did still inflict losses on the Dominican Republic and on Turks & Caicos, before dissipating over the open ocean.

### Losses mostly uninsured

…resulted in combined insured losses of USD 92 billion.

When HIM finally concluded their destructive journeys, countless homes and businesses across the impacted lands lay shattered in ruins. According to *sigma* data, HIM caused economic damages of USD 217 billion and insured losses of USD 92 billion. Insurance proceeds have made a significant contribution to recovery efforts but as the numbers show, a substantial proportion of the overall losses were uninsured. These costs will ultimately have to be borne by government, businesses and individuals.

Despite insurance industry pay outs, the amount of uninsured damage (protection gap) remains large.

A large degree of under-insurance in the US means that many businesses and households there did not have financial cover to help them recover from the hurricanes. The protection gap is likewise a severe issue in the many Caribbean islands that HIM also impacted. The Caribbean Catastrophe Risk Insurance Facility (CCRIF) covered a portion of the overall losses.[30] In the case of Irma and Maria, the CCRIF paid out USD 54 million for relief to those Caribbean island affected. The fast payout (within 14 days) and subsequent liquidity highlights an important benefit that insurance can provide in reducing existing protection gaps.

## HIM: one-of-a-kind, in their own ways

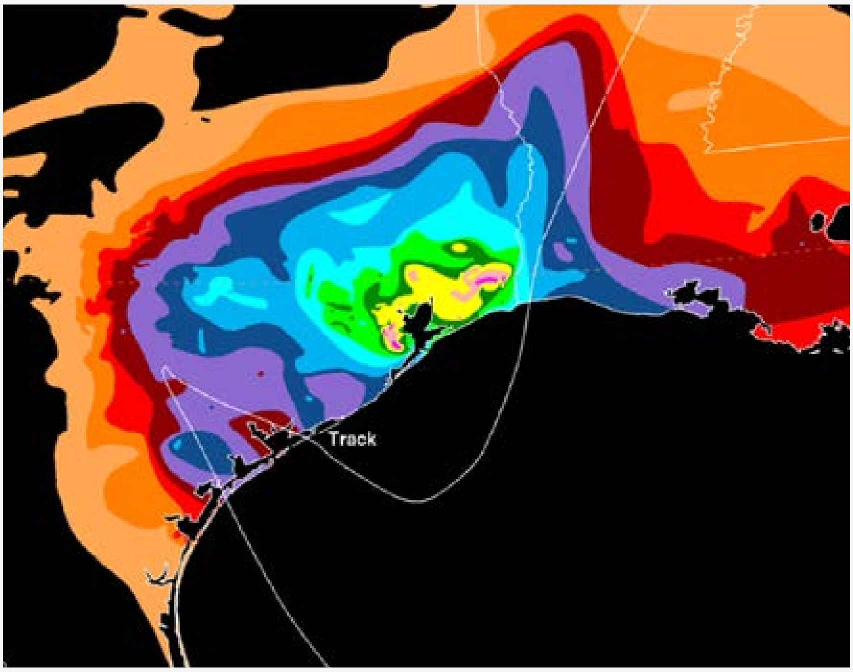
Harvey was one-of-a-kind, its defining feature being the very heavy rains it brought.

HIM each had special features. The uniqueness of Harvey, for instance, was the very excessive levels of rainfall that accompanied the storm, triggering the devastating floods in the Houston metropolitan area. Flooding caused by hurricanes is not a new phenomenon, but historical records tend to focus on wind intensity and include just scant mention of floods. There has previously been severe flooding after tropical cyclones in the US, most notably in 1916 (southeast US), 1921 (Texas), 1940 (south-east US), 1955 (northeast US, Hurricanes Connie/Diane), 1972 (northeast US, Hurricane Agnes) and 2001 (Texas, Tropical storm Allison). It is difficult to gauge with accuracy the extent of losses those rains would cause today given the changes in land use and flood protection levels over time. Considering all data available, though, it is unlikely that the scale of devastation from those earlier flood events would have been anything like that inflicted by the rains that came with Harvey.

[30] The CCRIF is a risk pool for Caribbean governments to offer protection against losses from natural disasters. Formed in 2007, the pool buys reinsurance in the open market and is designed so that payouts can be made within 14 days of an event, providing governments with liquidity for immediate post-disaster response efforts.

**Figure 8**
Hurricane Harvey: flood affectedness on zip code resolution level

- 1–2.99"
- 3–4.99"
- 5–6.99"
- 7–9.99"
- 10–14.99"
- 15–19.99"
- 20–24.99"
- 25–29.99"
- 30–34.99"
- 35–39.99"
- 40–44.99"
- 45–49.99"
- 50–59.99"
- 60–60.58"




Maximum: 60.58"
Nederland 1 SW, TX
Source: E.S. Blake, D.A. Zelinsky, National Hurricane Center Tropical Cyclone Report – Hurricane Harvey, Figure courtesy of David Roth (WPC) National Oceanic and Atmospheric Administration, 23 January 2018, 29018
https://www.nhc.noaa.gov/data/tcr/AL092017_Harvey.pdf

Irma was unique in maintaining category 5 intensity for more than three days.

Irma developed into the strongest category 5 storm, and it stayed at the highest intensity level for more than three full days. Previously, only Hurricane Allen in 1980 and the Cuba Hurricane of 1932 had stayed at the highest category for this long, but these hurricanes were largely offshore. The unique feature of Hurricane Irma was the number of Caribbean islands it struck while at category 5 status, causing devastation on Barbuda, St. Martin/St. Barthelemy, Angilla and the Virgin Islands.

Maria, meanwhile, inflicted an unprecedented level infrastructure damage in Puerto Rico.

With respect to Maria, apart from developing from category 1 to category 5 intensity in a very short space of time, the exceptional feature of the storm was the unprecedented scale of infrastructure devastation it wreaked, in Puerto Rico in particular. The island's electrical power grid was all but destroyed, and water distribution and road networks severely impacted: never before has an island suffered infrastructure destruction of such proportions in a single storm. With much of the infrastructure situated in isolated regions, recovery and clean-up efforts have proved very difficult.

## Bad, but not a worst-case scenario

Annual insured losses from hurricanes have reached similar levels as in 2017 before, most recently in 2005…

HIM inflicted very heavy losses, but are these truly unprecedented? Not many years ago, another series of Atlantic hurricanes resulted in losses not dissimilar to those inflicted by HIM. In 2005, Hurricanes Katrina, Rita and Wilma caused insured losses of USD 112 billion (indexed to 2017 values). Before then, however, no storms had caused losses of similar magnitude for almost 100 years. There is no monetary loss information from those days to help establish an "as-if today" view. Using Swiss Re's in-house hurricane model, however, it is possible to simulate the impact of historic storms onto today's built-up environment. Based on these calculations, it is fairly certain that the hurricanes in 1926 and potentially also 1928 would have caused insured and economic losses on a scale comparable to 2017 and 2005.

…and also in 1928 and 1926.

The so-called "Great Miami Hurricane" of 1926 would likely have resulted in losses in excess of those from HIM in the US alone. Additional losses from this and two other storms crossing the Bahamas would have added to the 1926 loss figure. The year 1928 was the year of another famous Florida storm: the "Lake Okeechobee Hurricane". In Puerto Rico, this storm is called San Felipe II, which crossed the island on a very similar track and intensity to Hurricane Maria, causing havoc. Between Florida and Puerto Rico, it passed close to the Dominican Republic, Turks & Caicos and Bahamas' capital Nassau, which would all have added to the overall loss tally. Last but not least, this hurricane is said to have produced significant rainfall amounts as it travelled north over the US continent, resulting in localised flooding.

HIM do not represent the worst-case scenario. Annual insured losses could go beyond USD 250 billion in a year, according to Swiss Re's model.

Looking back as far as the 1920s helps put the 2017 hurricane season into perspective. HIM were unique storms in their own ways, and are rare occurrences. But the impact of the 2017 season overall is not unprecedented. Nor are the 2017 losses a worst-case scenario. In a recent publication, using its natural catastrophe model Swiss Re showed that a single storm similar to Hurricane Andrew in 1992 could cause losses of USD 180 billion today.[31] And in terms of full-year accumulation, the model contains various scenarios where annual insured losses mount to well in excess of USD 250 billion. Such scenarios involve at least one Category 5 hurricane making landfall at a major metropolitan centre like Houston, Miami or New York, with additional severe events in the US, the Caribbean or Mexico in the same season.

[31] *Hurricane Andrew: The 20 miles that saved Miami*, Swiss Re, 9 August 2017.

The likelihood of insured losses resulting from an event being above a certain amount is a key probability metric for insurers.

But there are other metrics to assess probability, such as the number of years (historically) there have been at least four high-intensity hurricanes,...

...or the number of years in the last 100 with high levels of accumulated cyclone energy.

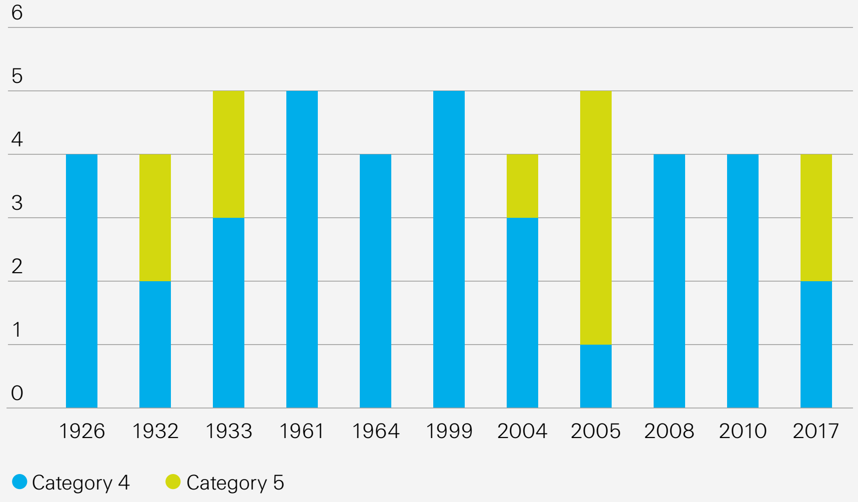
**Probability depends on metrics**

The probability of disaster events occurring is a central variable for insurers in their endeavours to price and insure risk on a sustainable basis. The likelihood of aggregated losses in a given year exceeding a certain amount (eg, USD 100 billion) is a key consideration for managing insurance risk.

However, the perspective of insured losses is only one of many options that could be considered to determine probability. For example, "how often in history have there been years with at least four hurricanes of the highest categories (category 4 and 5), out of which at least one was a category 5 storm?", could be an alternative. In the past 100 years – a period with data quality deemed adequate – this was observed to have happened five times: in 1932, 1933, 2004, 2005 and 2017.

Or, rather than counting storms, the frequency of the basin-wide activity through an intensity metric, the so-called accumulated cyclone energy (ACE),[32] could be another probability metric. In 2017, the ACE value equalled 226. During the past 100 years, this value was exceeded only five times (in 1926, 1933, 1995, 2004 and 2005).

**Figure 9**
Years with at least four hurricanes in the North Atlantic attaining the highest categories 4 and 5

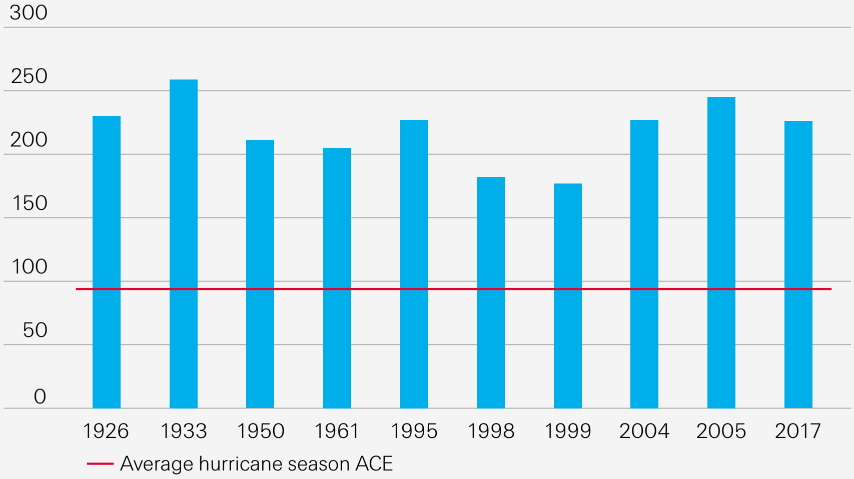



Note: Prior to 1945, there is general consensus that hurricane activity is not fully captured due to lack of data. Thus, the data basis cannot be considered entirely consistent, potentially undervaluing early years.
Source: HURDAT database, National Oceanic & Atmospheric Administration, http://www.aoml.noaa.gov/hrd/hurdat/Data_Storm.html

[32] See Wikipedia, at https://en.wikipedia.org/wiki/Accumulated_cyclone_energy

**Figure 10**
Top 10 accumulated cyclone energy value highs, in last 100 years

In 2017, ACE was about 2.5 times the average season value of around 90




Source: P. Klotzbach, *Tropical Meteorology Project*, Colorado State University, http://tropical.atmos.colostate.edu/Realtime/index.php?arch&loc=northatlantic

The more localised the area of consideration for an extreme event to occur is, the less likely it will happen.

The smaller the area of interest, and the higher the intensity considered, the less likely that area is to be affected by such an event. For instance, models indicate that the probability of a specific island like St Martin experiencing a catastrophic hit by a category 5 hurricane, as in the case of Irma, is significantly less than once in 100 years. Historical records from the time of permanent European presence at around 1650 support this view. The records indicate that there was a severe hurricane in 1772, but the reports are not specific enough to be able to establish its intensity. It is quite likely that there has never been a direct hit of a category 5 hurricane on the island in recorded history.

## Does global warming explain hurricane extremes?

Climate change did not cause HIM, but certain characteristics of the storms would be expected to occur more frequently in warmer climes.

Individual storms are never caused by one factor alone, be it climate change or anything else. Rather, hurricanes are the result of a complex and constantly evolving interplay between the atmosphere and the ocean surface. That said, some of the characteristics observed in HIM are those predicted to occur more frequently in a warmer world. Rather than attributing HIM to climate change, therefore, the question is which effects of global warming may have contributed to the impact of the 2017 hurricanes.

### Potential influences of global warming

- Rainfall: The level of rainfall is largely driven by the moisture available in the atmosphere. The capacity to hold such moisture follows a simple law of physics: the warmer the air, the more moisture it can hold. Climate models incorporating such laws of physics offer a means to assess the potential impact a warmer environment will have. A recent study by researcher Kerry Emanuel from the Massachusetts Institute of Technology suggests that the probability of 500 mm (20 inches) rainfall over Houston triggered by hurricanes has increased six-fold since the 1980s.[33] Some contest the large impact of global warming as presented in this study, but within the scientific community, there is consensus that rainfall levels are set to increase.

[33] K. Emanuel, *Assessing the present and future probability of Hurricane Harvey's rainfall*, Proceedings of the National Academy of Sciences of the United States of America, November 2017, http://www.pnas.org/content/early/2017/11/07/1716222114

- Storm surge: The flat Texas coastline is at high risk from storm surges that accompany hurricanes. For example, unaware of the approaching disaster and thus unable to escape from the rising floodwaters, an estimated 8000 people died in the Galveston Hurricane of 1900. Looking at the total damage inflicted by Hurricane Harvey, however, storm surge contributed only marginally to the losses, because the area impacted by storm surge was sparsely populated.

  Nevertheless, storm surge remains and is a growing concern in many areas around the world, one that is inextricably linked to global warming. The ocean surface level around the globe has risen steadily over the last 100 years, and by some 0.6m (2 feet) along the Texas coast specifically. The expansion of water as it warms and melting glaciers are causing the sea level rise, a phenomena that could even accelerate if, for example, the Greenland ice shield disintegrates and melts more rapidly than it has so far done. A rise of only a few millimetres per year may not sound alarming, but the long-term impacts can be dramatic. Using its proprietary catastrophe model, Swiss Re estimates that without implementation of additional protective measures, the probability of extreme storm surge damage in the northeast US due to higher seas will almost double in the next 40 years.[34]

- Hurricane intensification: Hurricanes Irma and in particular Maria intensified to category 5 very quickly, and some ask if this was due to global warming. Climate models do indicate that in a warmer environment, hurricanes will more frequently reach categories 4 and 5. The warmer the air and oceans, the more moisture there is, and that is the main driver of this model behaviour. However, specific storms are influenced by a large number of additional factors, all of which contribute to the evolution of a hurricane. For instance, it is highly uncertain if or how vertical wind shear – a measure of difference in wind directions at different levels of the atmosphere – will respond to further warming. So while climate model predictions are aligned with what was observed in Irma and Maria in 2017, this does not prove that global warming played a role in the rapid intensification of the storms. However, climate models have been predicting such events to happen more often in the future, and this should be cause for concern to all stakeholders, including the insurance industry

### Variability in hurricane activity

The 12-year absence of major hurricanes making US landfall has led to talk of a phase of low-level hurricane activity.

In the 20th century, hurricane seasons in the North Atlantic were observed to have gone through phases of increased and decreased activity spanning many years. These phases of activity are commonly associated with periods of warmer-than-average and colder-than-average sea surface temperatures (Atlantic Multi-decadal Oscillation or AMO). From 1995, the ocean was considered to be in a "warm" phase, with increased hurricane activity compared to the long-term average. In the last two to three years, however, this consensus understanding has been questioned.

However, the world has been and remains in an active phase of hurricane activity.

Just as a specific hurricane cannot prove climate change, nor can the year 2017 alone serve as a proof that North Atlantic hurricane seasons remain active. Looking at all available data, however, there are strong indications that the North Atlantic is still in an active phase of hurricane activity. For example, AMO indices remain at elevated levels for the time being and show no signs of returning to more average levels. Moreover, despite a lack in major landfalls in the US and the Caribbean, the years 2008, 2010, 2011, 2012 and 2016 had been very active in terms of offshore hurricane activity. The North Atlantic seems to remain in an active phase of hurricane activity, irrespective of climate change influences that may come on top of it.

[34] *sigma* 2/2013: Natural catastrophes and man-made disasters in 2012: A year of extreme weather events in the US, Swiss Re, 27 March 2013.

It could even be that there will be no return to a phase of low-level activity.

It could be that there will be no return to phases of low hurricane activity. In September 2017, the Swiss Re Institute and Columbia University held a combined science/insurance industry conference *Atlantic Climate Variability – Dynamics, Prediction and Hurricane Risk*.[35] One idea presented at the conference and gaining more traction in the scientific community is that air pollution may have helped to reduce hurricane activity in the 1970s and 1980s. If so, and assuming clean air remains a societal priority, a return to the low-level-of-hurricane-activity phase of those years may not happen again, any time soon.

## Do hurricanes come in clusters?

Clusters amplify (accumulate) the loss potential of hurricanes.

HIM resulted in significant accumulated insured losses of USD 92 billion. A key challenge for the insurance industry is to assess the risk of loss accumulation, and the close sequence of the three storms has triggered the question: "do hurricanes come in clusters?" Internal and external analysis of historical data suggest that even beyond obvious intra-season patterns, hurricanes do show some clustering and do not form entirely at random. Further, the observation of storm clustering seems reasonable considering that at least some factors driving hurricane development tend to be persistent over a certain period of time, as follows:

- Ocean heat content: Over larger areas, sea surface temperatures tend to remain stable relative to the typical temperature in a given season. In other words: if upper ocean temperatures are anomalously warm in a given season, then they will tend to remain so for a longer time period. The year 2017 is a perfect example: sea surface temperatures were roughly 1°Celsius above the historical mean throughout the peak hurricane months.

  That said, the stronger a hurricane is, the more the upper ocean layer is mixed with colder waters from below the surface in a strip of some 100 kilometres around its track. Any subsequent hurricane crossing such a stretch of colder surface water will be inhibited in its further development.

- Atmospheric humidity: in contrast to sea surface temperatures, humidity is far less constant, as air masses in the atmosphere move constantly over large distances. In an environment of persistently higher sea surface temperatures, however, it stands to reason that the prevalence of humid air masses increases.

Other factors, however, are less persistent;

- Vertical wind shear: wind shear – just as humidity - demonstrates high variability over short distances and a few days. That said, there is some statistical persistence connected to large-scale atmospheric teleconnections. During El Nino years, for example, wind shear in the North Atlantic tends to increase on average, thus inhibiting hurricane formation.

- Ventilation/outflow: the importance of good upper troposphere ventilation, especially for major hurricanes, is often ignored. As in the combustion engine, ventilation enables an efficient transfer of energy within the hurricane, and is key for attaining major hurricane intensities. But like humidity and wind shear, the persistence of favourable outflow conditions seems low.

- Initial disturbance: hurricanes need an initial spark, much like a wildfire would. In atmospheric science, such sparks are termed initial disturbances, comparable to summer thunderstorms. These can follow certain patterns (eg, in the form of so-called African Easterly Waves), but there are no indications that there are seasonally persistent active or inactive phases.

[35] M. Schwarz, "How well can we predict North Atlantic hurricane activity?", *Open Minds*, Swiss Re, 2 October 2017, https://openminds.swissre.com/stories/1320/

These considerations indicate that multiple conditions need to align to trigger a hurricane trilogy like HIM. For example after Hurricane Maria, in October 2017 the ocean waters were still warmer than usual. However, with an absence of other conditions favourable for hurricane development, the month – which normally has a high level of storm activity – was relatively quiet.

## Conclusion

Large hurricane cluster events are rare but not unprecedented…

From an insurance loss perspective, HIM were not unprecedented events per se. Each of the hurricanes had their unique destructive forces, and the accumulated losses from the three storms were very high. But, while storms resulting in losses of such magnitude occur rarely, they have happened before, most recently in 2005. Nor do HIM represent a worst-case scenario. Swiss Re's modelling tools simulate hurricane event scenarios where insured losses are well in excess of USD 250 billion.

…and will likely occur more often in the future with more frequent convergence of conditions favourable to hurricane formation.

Observation of historical data indicates that hurricanes do not appear at random, but tend to cluster in groups. This is an important consideration not least because, irrespective of the absence of major storm landfall in the US during the last 12 years, the North Atlantic seems to still be in an active phase of hurricane activity. Climate model predictions of more frequent occurrence of various characteristics observed in HIM, and thereby likely also more storm clustering, are cause for concern. Similar to Hurricanes Katrina, Rita and Wilma in 2005, the HIM experience tested the insurance industry's ability to absorb accumulated losses from multiple events. From a risk management perspective, these events highlight that aside from focus on the severity of a single major event, hurricane clustering has emerged as an as-important variable to consider in assessing future loss potential scenarios.

More and more, insurers needs to consider hurricane frequency as much as severity, and also include secondary risk factors in their modelling of potential loss scenarios.

With respect to Harvey specifically, this storm highlighted the dangers that hurricanes can bring in the form of excessive rains and resulting flooding. With a warming climate, the frequency of events that combine heavy rains and winds will likely increase. So too will events with severe storm surge, in view of rising sea levels. In the interests of societal resilience, therefore, further research on clustering of hurricanes and the impact of global warming on storm formation is required. At the same time, it is incumbent in the insurance industry to include secondary risk factors in risk assessment and modelling. Economic growth alone will increase the requirement for protection solutions against both single extreme events as well as an accumulation of multiple event losses over a one-year period. Evolving climatic conditions, notably rising seas levels, could make those needs ever-more pressing.

# Tables for reporting year 2017

**Table 5**
List of major losses in 2017 according to loss category

| | Number | as % | Victims | as % | Indexed to 2017 Insured loss (in USD m) | as % |
|---|---|---|---|---|---|---|
| **Natural catastrophes** | **183** | **60.8%** | **8470** | **74.3%** | **138057** | **95.7%** |
| Storms | 82 | | 1642 | | 111475 | |
| Drought, bush fires, heat waves | 14 | | 435 | | 14237 | |
| Hail | 8 | | 0 | | 7549 | |
| Cold, frost | 5 | | 153 | | 1038 | |
| Earthquakes | 12 | | 1184 | | 1615 | |
| Floods | 55 | | 3515 | | 2144 | |
| Other natural catastrophes | 7 | | 1541 | | 0 | |
| **Man-made disasters** | **118** | **39.2%** | **2934** | **25.7%** | **6246** | **4.3%** |
| Major fires, explosions | 45 | 15.0% | 477 | 4.2% | 5439 | 3.8% |
| Oil, gas | 15 | | 36 | | 3056 | |
| Industry, warehouses | 14 | | 73 | | 1845 | |
| Other buildings | 11 | | 308 | | 382 | |
| Other fires, explosions | 3 | | 22 | | 81 | |
| Department stores | 2 | | 38 | | 76 | |
| Miscellaneous | 21 | 7.0% | 925 | 8.1% | 200 | 0.1% |
| Social unrest | 1 | | 0 | | 200 | |
| Terrorism | 13 | | 731 | | 0 | |
| Other miscellaneous losses | 7 | | 194 | | 0 | |
| Aviation disasters | 7 | 2.3% | 165 | 1.4% | 410 | 0.3% |
| Space | 2 | | 0 | | 188 | |
| Crashes | 3 | | 165 | | 131 | |
| Damage on ground | 2 | | 0 | | 90 | |
| Maritime disasters | 33 | 11.0% | 1163 | 10.2% | 197 | 0.1% |
| Drilling platforms | 1 | | 0 | | 90 | |
| Freighters | 2 | | 22 | | 75 | |
| Tankers | 1 | | 0 | | 32 | |
| Passenger ships | 27 | | 1087 | | 0 | |
| Other maritime accidents | 2 | | 54 | | 0 | |
| Rail disasters (incl. cableways) | 10 | | 140 | 0.6% | 0 | |
| Mining accidents | 2 | | 64 | 1.2% | 0 | |
| **Total** | **301** | **100.0%** | **11404** | **100.0%** | **144303** | **100.0%** |

Source: Swiss Re Institute

# Tables for reporting year 2017

**Table 6**
The 20 most costly insurance losses in 2017

| Insured loss (in USD mn) | Victims | Date (start) | Event | Country/region |
|---|---|---|---|---|
| 32 000 | 136 | 19.9.2017 | Hurricane Maria | US, Caribbean |
| 30 000 | 126 | 6.9.2017 | Hurricane Irma | US, Caribbean |
| 30 000 | 89 | 25.8.2017 | Hurricane Harvey (Cat 4), severe inland flood in Houston | US |
| 7 710 | 22 | 8.10.2017 | Wildland fire "Tubbs Fires" | US |
| 2 666 | 6 | 8.10.2017 | Wildland fire "Atlas fire" | US |
| 2 507 | – | 8.5.2017 | Hailstorm, thunderstorms, tornadoes, severe hail damage in Denver, CO | US |
| 1 967 | – | 26.3.2017 | Hailstorm, thunderstorms, tornadoes | US |
| 1 787 | – | 4.12.2017 | Wildland fire "Thomas Fire" | US |
| 1 600 | 2 | 6.3.2017 | Thunderstorms, tornadoes, hail | US |
| 1 549 | – | 11.6.2017 | Hailstorm in Minnesota | US |
| 1 370 | 6 | 28.2.2017 | Thunderstorms, tornadoes, large hail | US |
| 1 306 | 12 | 28.3.2017 | Cyclone Debbie, storm surge | Australia |
| 1 200 | 369 | 19.9.2017 | Earthquake Mw 7.1 | Mexico |
| 1 131 | – | 27.6.2017 | Thunderstorms, large hail, tornadoes | US |
| 1 107 | 27 | 23.8.2017 | Typhoon Hato | China, Viet Nam, Hong Kong |
| 930 | – | 19.4.2017 | Cold spell brings frost damage | Europe |
| ns | – | 11.1.2017 | Fire at a refinery | United Arab Emirates |
| 888 | – | 18.10.2017 | Typhoon Lan (Paolo) | Philippines, Japan |
| 853 | 24 | 18.1.2017 | Major tornado outbreak, 1 EF3 tornado in Hattiesburg, MS | US |
| ns | – | 14.3.2017 | Fire at a refinery | Canada |

ns = not showing
Source: Swiss Re Institute and Cat Perils.

**Table 7**
The 20 worst catastrophes in terms of victims 2017

| Victims | Insured loss (in USD mn) | Date (start) | Event | Country/region |
|---|---|---|---|---|
| 1 141 | – | 14.8.2017 | Heavy rains trigger flood and massive landslide and debris flow in Babadorie River Valley | Sierra Leone |
| 630 | 8 | 12.11.2017 | Earthquake Mw 7.3 on the Iran-Iraq border | Iran, Iraq |
| 514 | – | 12.8.2017 | Floods caused by heavy monsoon rains in Bihar – River Gandak burst its banks in 8 points | India |
| 369 | 1 200 | 19.9.2017 | Earthquake Mw 7.1 | Mexico |
| 336 | – | 31.3.2017 | Torrential rains caused Mocoa, Sangoyaco and Mulato to overflow and trigger massive landslide | Colombia |
| 331 | – | 22.12.2017 | Tropical storm Tembin (Vinta) triggers flooding | Philippines |
| 311 | – | 24.11.2017 | Bomb explosion at a mosque | Egypt |
| 293 | 33 | 24.5.2017 | Torrential rains trigger floods along the Kalu River Basin, landslides | Sri Lanka |
| 264 | – | 12.4.2017 | Heatwave | India |
| 251 | – | 14.1.2017 | Heavy rains exacerbated by remnants of Cyclone Dineo trigger floods | Zimbabwe |
| 224 | – | 20.7.2017 | Floods caused by heavy monsoon rains | India |
| 200 | – | 16.8.2017 | Landslide | Congo, Democratic Republic of (DRC) |
| 184 | 400 | 15.1.2017 | Severe floods | Peru |
| 172 | – | 26.6.2017 | Monsoon floods | Pakistan |
| 165 | – | 4.2.2017 | Snow storms, avalanches | Afghanistan, Pakistan |
| 160 | – | 13.6.2017 | Heavy rains trigger multiple landslides | Bangladesh |
| 156 | – | 2.7.2017 | Floods caused by heavy monsoon rains – precipitation driven floods | India |
| 136 | 32 000 | 19.9.2017 | Hurricane Maria | US, Puerto Rico, US Virgin Island, Caribbean |
| 134 | – | 11.8.2017 | Floods caused by heavy monsoon rains | Nepal |
| 126 | 30 000 | 6.9.2017 | Hurricane Irma | US, Caribbean |

Source: Swiss Re Institute and Cat Perils.

**Table 8**
Chronological list of all natural catastrophes 2017

## Flood

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 1.1.–31.1. | Thailand<br>Nakhon Si Thammarat, Surat Thani Agromet, Narathiwat, Nakhon Si Thammarat | River floods – severe damage to palm and rubber plantations | 96 dead |
| 6.1.–9.1. | United States<br>CA, CO, ID, OR, NV, UT | Pineapple Express brings snow and flood to West Coast | 3 dead<br>USD 100m–300m insured loss<br>USD 400m total damage |
| 14.1.–15.3. | Zimbabwe<br>Matabeleland, Midlands, Masvingo, Mashonaland West, Manicaland, Metropolitan | Heavy rains exacerbated by remnants of Cyclone Dineo trigger floods – 2579 houses destroyed, major damage to infrastructure | 251 dead<br>128 homeless<br>USD 189m total damage |
| 15.1.–29.3. | Peru<br>Tumbes, Piura, Lambayeque, La Libertad, Ancas h, Lima, Ica, Cajamarca | Severe floods | 164 dead, 20 missing<br>505 injured<br>149 848 homeless<br>USD 400m insured loss<br>USD 3.1bn total damage |
| 17.1.–22.1. | Pakistan<br>Balochistan | Snowfall followed by heavy rains cause floods – 1050 houses damaged | 13 dead<br>650 injured |
| 8.2.–22.2. | United States<br>Butte County, California | Pineapple Express brings strong winds and flooding to California – severe damage to the Oroville Dam spillway caused evacuation of 200 000 people; Coyote Creek overflowed its banks and triggers flood in San Jose | 5 dead<br>USD 100m–300m insured loss<br>USD 1.5bn total damage |
| 15.3.–4.4. | Malawi<br>Karonga | Floods – 665 houses destroyed | 3,657 homeless |
| 21.3.–23.3. | Angola<br>Luanda | Flash floods – 700 houses destroyed, 5773 houses damaged | 11 dead, 9 missing<br>2 000 homeless |
| 29.3.–7.4. | Bangladesh<br>Sylhet, Moulavibazar, Sunamganj, Habiganj, Netrokona, Kishoreganj | Floods along Surma and Kushiyara rivers – 1860 houses destroyed, 15 345 houses damaged, 219 848 ha of cropland lost | USD 128m total damage |
| 31.3.–4.4. | Colombia<br>Mocoa, Putumayo | Torrential rains caused Mocoa, Sangoyaco and Mulato to overflow and trigger massive landslide | 336 dead<br>389 injured<br>600 homeless |
| 1.4. | Indonesia<br>East Java | Heavy rains trigger landslide – 32 houses destroyed | 28 dead |
| 3.4.–7.4. | New Zealand<br>Edgecumbe, Bay of Plenty, North Island | Extratropical cyclone and moisture from remnants of Cyclone Debbie trigger flood – Whakatāne and Rangitaiki Rivers burst their banks | NZD 100m (USD 71m) total damage<br>NZD 91m (USD 65m) insured loss |
| 20.4. | Colombia<br>Manizales | Heavy rains trigger landslide | 16 dead, 7 missing<br>20 injured |
| 25.4.–7.5. | United States<br>MO, AR, TX, IN, OK, IL, PA, MS, OH, TN, KY, NY, LA, AL | Midwest floods, river floods, flash floods, severe flood damage in Missouri and Arkansas, wind damage in other states | 20 dead<br>50 injured<br>USD 600m–1bn insured loss<br>USD 1.7bn total damage |

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 5.5.–7.5. | Canada<br>Gatineau, Outaouais region | Flood in the Great Lakes and along Ottawa River Basin due to snow melt and heavy precipitations – 5371 houses flooded in Quebec | 2 dead<br>CAD 113m (USD 91m) insured loss |
| 8.5.–19.5. | Kenya, Tanzania<br>Kwale, Mombasa, Taita Taveta, Garrissa | Torrential rains trigger floods | 26 dead |
| 24.5. | Russia<br>Stavropol Kray | Heavy rains trigger flash flood – 850 houses destroyed, 2371 houses damaged | 2 077 homeless |
| 24.5.–5.6. | Sri Lanka<br>Sabaragamuwa, Rathnapura, Matara, Hambantota, Kalutara, Galle | Torrential rains trigger floods along the Kalu River Basin, landslides – 3048 houses destroyed, 76 803 houses damaged | 219 dead, 74 missing<br>154 injured<br>109,890 homeless<br>LKR 5bn (USD 33m) insured loss<br>LKR 59.744bn (USD 389m) total damage |
| 26.5.–29.5. | Brazil<br>Pernambuco, Alagoas | Torrential rains trigger floods, landslides | 12 dead<br>4 000 homeless |
| 13.6.–16.6. | Niger, Ivory Coast<br>Abidjan | Floods – damage to crops | 19 dead<br>2 000 homeless<br>USD 5m total damage |
| 13.6.–18.6. | Bangladesh<br>Bandarban, Chittagong, Rangamati, Khagrachari, Cox's Bazar districts | Heavy rains trigger multiple landslides – 11 000 houses damaged or destroyed | 160 dead<br>187 injured<br>2 512 homeless<br>LKR 30bn (USD 195m) total damage |
| 22.6.–5.7. | China<br>Hunan, Sichuan, Yunnan, Chongqing, Guizhou, Hubei, Anhui, Jiangxi, Zhejiang | Severe floods along the Yangtze River | 33 dead, 15 missing<br>8 injured<br>USD 6bn total damage |
| 24.6. | China<br>Xinmo village, Diexi, Mao County, Sichuan | Heavy rains trigger landslide | 10 dead, 73 missing |
| 26.6.–15.9. | Pakistan<br>Gilgit-Baltistan, Sindh, Punjab, Khyber Pakhtunkh-wa, Balochistan | Monsoon floods – 440 houses destroyed | 167 injured<br>172 dead<br>USD 110m total damage |
| 29.6.–30.6. | Germany<br>Berlin, Brandenburg | Flash flood | EUR 60m (USD 72m) insured loss<br>EUR 130m (USD 156m) total damage |
| 30.6.–14.8. | Sudan<br>Khartoum, Northern State, Sennar, Kassala, Gezira, West Kordofan, White Nile | River floods, flash floods – 8120 houses destroyed, 5987 houses damaged | 25 dead<br>112 injured |
| 2.7.–30.7. | India<br>Assam, Arunachal Pradesh, Nagaland, Manipur | Floods caused by heavy monsoon rains – precipitation driven floods | 156 dead<br>INR 23bn (USD 360m) total damage |
| 5.7.–6.7. | Japan<br>Fukuoka, Oita (Kyusyu) | Torrential rains and Typhoon N.3 bring floods and landslides in northern Kyushu – 276 houses destroyed, 1141 houses damaged, 2169 houses flooded | 36 dead<br>JPY 12bn (USD 107m) insured loss<br>JPY 93.16bn (USD 827m) total damage |
| 5.7.–29.7. | Thailand<br>Sakon Nakhon, Ayutthaya, Nakhon Phanom, Roi Et, Mukdahan | Monsoon floods | 23 dead<br>THB 1bn (USD 31m) insured loss<br>THB 10bn (USD 307m) total damage |
| 6.7.–9.7. | China<br>Beijing, Tianjin, Hebei | Flash floods | 1 dead<br>CNY 1.8bn (USD 277m) total damage |

## Tables for reporting year 2017

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 8.7. | Nigeria<br>Ekiti, Osun, Akwa Ibom, Kebbi, Niger, KwaraEbonyi, Enugu, Abia, Oyo, Lagos | Floods | 20 dead<br>500 homeless |
| 13.7.–17.7. | China<br>Hebei, Shanxi, Liaoning, Heilongjiang, Shaanxi, Gansu, Ningxia Hui | Floods – 58 000 houses damaged | USD 2.5bn total damage |
| 17.7. | Afghanistan<br>Badakhshan, Kabul, Nangarhar | Flash floods – 260 houses destroyed | 36 dead<br>22 injured |
| 20.7.–31.8. | India<br>Gujarat | Floods caused by heavy monsoon rains | 224 dead<br>INR 20bn (USD 313m) total damage |
| 31.7.–3.8. | India<br>West Bengal, Jharkhand | Floods caused by heavy monsoon rains – 7868 houses destroyed, 44 361 houses damaged, 1 059 000 ha of cropland flooded | 58 dead<br>25,000 homeless<br>INR 7.8bn (USD 122m) total damage |
| 2.8.–3.8. | Viet Nam<br>Mu Chang Chai (Yen Bai), Muong La (Son) | Flash floods, landslides | 23 dead<br>16 injured<br>VND 500bn (USD 22m) total damage |
| 3.8.–10.8. | China<br>Longnan, Lanzhou, Baiyin City, Gansu Province | Rainstorms and floods – 2300 houses destroyed, 11 900 houses damaged, 700 ha of cropland destroyed, 10 800 ha of cropland flooded | 9 dead, 1 missing<br>9 900 homeless<br>CNY 930m (USD 143m) total damage |
| 11.8.–14.8. | Nepal<br>Terai | Floods caused by heavy monsoon rains – 41 626 houses destroyed, 150 510 houses damaged, severe damage to agriculture and livestock sector | 134 dead<br>22 injured<br>NPR 60.717bn (USD 595m) total damage |
| 12.8.–16.8. | Bangladesh<br>Kurigram, Gaibandha, Bogra, Dinajpur, Sirajganj | Heavy monsoon rains trigger floods – 593 247 houses flooded and 650 000 ha of cropland flooded | 117 dead<br>297 254 injured<br>USD 500m total damage |
| 12.8.–26.8. | India<br>Araria, Jogbani (Bihar) | Floods caused by heavy monsoon rains in Bihar – River Gandak burst its banks in 8 points | 514 dead<br>INR 100bn (USD 1.567bn) total damage |
| 26.8.–27.8. | Niger<br>Niamey, Agadez, Diffa, Dosso, Maradi, Tahoua, Tillabery, Zinder | Torrential rains trigger flash floods – 12 000 houses destroyed, 9804 ha of cropland lost | 56 dead<br>USD 10m total damage |
| 28.8.–29.8. | Canada<br>Windsor, Tecumseh, Essex, ON | Heavy rainfall triggers flood in Windsor, ON | CAD 161m (USD 129m) insured loss |
| 29.8. | India<br>Mumbai, Thane, Palghar | Flash flood | 14 dead<br>INR 5bn (USD 78m) insured loss<br>USD 300m total damage |
| 10.9. | Italy<br>Livorno | Flash floods | 8 dead<br>EUR 180m (USD 216m) total damage |
| 11.9. | Croatia<br>Zadar, Knin | Torrential rains trigger flash flood and wind damage, 1 tornado – severe damage to infrastructure | HRK 40m (USD 6m) insured loss<br>HRK 1bn (USD 161m) total damage |
| 19.9. | Congo, Democratic Republic of (DRC) | Flood | 105 dead |
| 26.9. | Uganda | Flood | 25 dead |
| 9.10.–12.10. | Viet Nam, Thailand<br>Yen Bai, Hoa Binh | Remnants of a tropical depression trigger heavy rains and floods | 27 dead<br>32 injured<br>VND 2000bn (USD 88m) total damage |

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 23.10.–26.10. | Guatemala<br>Alta verapaz | Heavy rains trigger floods and landslides (Tropical Depression 16) – 4341 houses damaged | 25 dead |
| 30.10. | India<br>Chennai, Tamil Nadu | Flash flood | 21 dead |
| 4.11.–5.11. | Thailand<br>Penang | Flash floods, landslides | 7 dead<br>3000 homeless<br>USD 50m total damage |
| 7.11. | Colombia<br>Corinto, Cauca Department | Heavy rains trigger flash flood and mudflow – 37 houses destroyed, 17 damaged | 4 dead, 18 missing<br>30 injured |
| 15.11.–18.11. | Greece, Italy<br>Mandra, Nea Peramos, Megara | Flash floods, hail, thunderstorms – 428 buildings damaged | 23 dead<br>24 injured |
| 27.11.–1.12. | Indonesia<br>East Java, Yogyakarta, Bali | Remnants of Tropical Storm Cempaka bring flood | 11 dead<br>35 injured<br>2000 homeless |
| 11.12.–12.12. | Italy<br>Lentigione di Brescello, (Reggio Emilia), Colorno (Parma) | Torrential rains trigger floods, rivers Enza, Parma and Secchia burst their banks – damages to commercial facilities and private homes | EUR 40m (USD 48m) insured loss |

## Storms

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 1.1.–3.1. | United States<br>GA, TX, AL, LA, MS | Thunderstorms, tornadoes, torrential rains | 3 dead<br>USD 100m–300m insured loss<br>USD 200m total damage |
| 12.1.–13.1. | France, Germany, Switzerland, Luxembourg | Winter storm Egon, icy winds, heavy snowfall, floods | 3 dead<br>EUR 275m (USD 331m) insured loss |
| 18.1.–23.1 | United States<br>CA, GA, MS, TX, FL, AL, LA, SC | Major tornado outbreak, 1 EF3 tornado in Hattiesburg, MS | 24 dead<br>200 injured<br>USD 600m–1bn insured loss<br>USD 1.1bn total damage |
| 31.1.–4.2. | Iran<br>Damavand | Blizzard, heavy snow fall, avalanches | 5 dead, 2 missing<br>79 injured |
| 1.2.–8.2. | France, Spain | Windstorms Kurt, Leiv, Marcel | 17 injured<br>EUR 72m (USD 86m) insured loss |
| 4.2.–7.2. | Afghanistan, Pakistan<br>Nuristan (Afghanistan), Chitral (Pakistan) | Snow storms, avalanches | 165 dead<br>64 injured |
| 7.2. | United States<br>LA, FL, AL, MS | Thunderstorms, hail, tornadoes | 1 dead<br>33 injured<br>USD 100m–300m insured loss<br>USD 160m total damage |
| 15.2.–17.2 | Mozambique, Botswana<br>Inhambane, Vilanculos | Cyclone Dineo, flooding – 33014 houses destroyed, 20000 houses damaged, 30000 ha of crop lost | 7 dead<br>100 injured<br>USD 17m total damage |
| 19.2.–20.2. | United States<br>San Antonio, TX | Thunderstorms, hail, tornadoes, flash floods | USD 100m–300m insured loss |

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 19.2.–21.2. | United States<br>CA | Strong winds, flooding | USD 25m–100m insured loss<br>USD 120m total damage |
| 23.2.–24.2. | United Kingdom, Germany, Belgium, Netherlands, Ireland | Windstorm Thomas (Doris) | 3 dead<br>USD 292m insured loss |
| 25.2. | United States<br>VA, PA | Thunderstorms, large hail, tornadoes | USD 100m–300m insured loss<br>USD 180m total damage |
| 28.2.–2.3. | United States<br>IL, MO, IN, KY, OH, TN, GA, IA, AR, NC, VA, AL, SC, WV, MD, MI | Thunderstorms, tornadoes, large hail | 6 dead<br>USD 1bn–3bn insured loss<br>USD 1.8bn total damage |
| 1.3. | China<br>Jiangsu, Henan | Thunderstorms, hailstorms – >13 700 houses damaged or destroyed | 1 dead<br>2 000 homeless<br>CNY 192m (USD 30m) total damage |
| 6.3.–7.3. | France | Windstorm Zeus | 2 dead<br>EUR 284m (USD 341m) insured loss |
| 6.3.–9.3. | United States<br>MO, MI, NY, MN, IA, OH, IL, WI, AR, OK, NE | Thunderstorms, tornadoes, hail | 2 dead<br>15 injured<br>USD 1bn–3bn insured loss<br>USD 2.2bn total damage |
| 7.3.-10.3. | Madagascar<br>Sava, Sambava, Analanjirofo, Sofia, Diana | Cyclone Enawo, flooding – 37 988 houses destroyed, 56 057 houses damaged, severe damage to vanilla plantations | 81 dead, 18 missing<br>253 injured<br>247 000 homeless |
| 8.3.–9.3. | Canada<br>Windsor, Sarnia. London, Niagara Falls, St Catherines, Hamilton (On) | Windstorm in southern Ontario | 1 dead<br>CAD 105m (USD 84m) insured loss |
| 19.3. | Ghana<br>Kintampo waterfalls, Brong-Ahafo | Thunderstorms, strong winds, heavy rains – falling trees trap swimmers at Kintampo waterfalls | 20 dead<br>12 injured |
| 21.3.–22.3. | United States<br>SC, TN, GA, NC | Thunderstorms, hail | 1 dead<br>USD 600m–1bn insured loss |
| 25.3. | India<br>Malda, West Bengal | Thunderstorms – 20 000 houses damaged or destroyed | 4 dead<br>20 injured<br>60 000 homeless |
| 28.3.–31.3. | United States<br>TX, VA, NC, OK | Thunderstorms, large hail, tornadoes | USD 100m–300m insured loss<br>USD 280m total damage |
| 28.3.–10.4. | Australia<br>Queensland, New South Wales | Cyclone Debbie with winds up to 263 km/h, storm surge, floods in southeast Queensland and northeast New South Wales along Logan and Albert Rivers, damage to railway networks and ports in the Bowen Basin disrupt production at 22 coal mines, damage to crops | 12 dead<br>AUD 1.67bn (USD 1.306bn) insured loss |
| 2.4.–3.4. | United States<br>TX, GA, LA, MS, AL, SC, FL, AR, NC | Thunderstorms, tornadoes, hail, flash floods | USD 100m–300m insured loss |
| 4.4.–6.4. | United States<br>AL, KY, GA, VA, SC, TX, MO, NC, TN, FL, MD, OK, AR, KS, DC | Thunderstorms, tornadoes, hail | USD 600m–1bn insured loss |
| 5.4.–7.4. | Canada<br>Ste. Therese, Blainville, Rosemere, Ste. Hyacinthe (QC) | Winter storm, flooding | CAD 108m (USD 87m) insured loss |
| 7.4.–8.4. | United States<br>OR, CA | Thunderstorms, flash floods | 1 dead<br>USD 25m–100m insured loss<br>USD 100m total damage |

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 10.4.–11.4. | United States<br>TX, IL, IN | Thunderstorms, tornadoes | USD 100m–300m insured loss<br>USD 280m total damage |
| 15.4.–17.4. | China<br>Henan, Hubei, Shaanxi, Chong-qing | Thunderstorms | 5,000 homeless<br>USD 200m total damage |
| 15.4.–17.4. | Iran<br>East Azerbaijan, West Azerbaijan, Kurdistan, Zanjan, Mazandaran, Ardebil | Torrential rains trigger river flood | 42 dead<br>USD 300m total damage |
| 21.4.–25.4. | United States<br>TX, TN, OK, NC, VA, SC | Thunderstorms, large hail, tornadoes, floods | USD 600m–1bn insured loss |
| 26.4. | United States<br>TX | Thunderstorms, large hail, tornadoes | USD 25m–100m insured loss<br>USD 100m total damage |
| 3.5.–5.5. | United States<br>TX, LA, GA, VA, NC | Thunderstorms, tornadoes, hail | USD 100m–300m insured loss |
| 15.5.–18.5. | United States<br>IL, WI, MN, OK, IA, NY | Thunderstorms, hail, tornadoes | USD 600m–1bn insured loss |
| 23.5.–24.5. | Canada<br>Vancouver, Edmonton, Calgary, Red Deer, Lacombe | Thunderstorms, hail, flood | CAD 66m (USD 52m) insured loss<br>CAD 90m (USD 72m) total damage |
| 23.5.–24.5. | China<br>Hubei, Hunan, Chongqing, Sichuan, Guizhou, Yunnan, Guangxi | Thunderstorms, large hail, floods – >4000 houses damaged or destroyed | 9 dead<br>6 000 homeless<br>CNY 400m (USD 61m) total damage |
| 27.5.–28.5. | United States<br>MO, TN, VA, OK, KY | Thunderstorms, large hail, tornadoes | USD 300m–600m insured loss<br>USD 600m total damage |
| 28.5. | India<br>Jamui, Champaran, Vaishali, Samastipur, Bihar | Thunderstorms – 250 houses damaged | 29 dead |
| 29.5. | Russia<br>Moscow | Thunderstorms – 243 buildings, 2000 vehicles damaged | 16 dead<br>200 injured |
| 30.5.–31.5. | Bangladesh, India, Myanmar (Burma) | Cyclone Mora – 64 999 houses damaged, severe impact on makeshift refugees settlements in Bangladesh | 9 dead<br>136 injured<br>USD 50m total damage |
| 2.6.–4.6. | United States<br>TX | Thunderstorms, large hail | USD 100m–300m insured loss<br>USD 160m total damage |
| 6.6.–8.6. | South Africa<br>Cape Town | Winter storm, coastal flooding – 700 buildings damaged by flooding | 8 dead<br>ZAR 1.8bn (USD 145m) insured loss<br>ZAR 3.5bn (USD 283m) total damage |
| 12.6.–14.6. | United States<br>TX, WY, Midwest | Thunderstorms, large hail, tornadoes in Midwest | USD 600m–1bn insured loss<br>USD 1.2bn total damage |
| 16.6.–19.6. | United States<br>NE, IA, KS, MO, PA, IL, VA, NY | Thunderstorms, hail, tornadoes | USD 300m–600m insured loss |
| 27.6.–29.6. | United States<br>NE, IA, IL | Thunderstorms, large hail, tornadoes | USD 1bn -3bn insured loss<br>USD 1.4bn total damage |
| 3.7.–4.7. | Japan<br>Kyushu, Chugoku | Tropical Storm Nanmadol | 38 dead, 5 missing<br>28 injured<br>USD 107m insured loss |
| 11.7.–12.7. | United States<br>IL, MN | Thunderstorms, hail, flash floods, tornadoes | USD 100m -300m insured loss |
| 13.7. | China<br>Jilin City, Siping, Yanbian | Thunderstorms, floods – 739 houses destroyed, 2396 houses severely damaged, 2173 houses moderately damaged; 10 500 ha of crops destroyed | 7 dead, 1 missing<br>CNY 960m (USD 148m) total damage |

## Tables for reporting year 2017

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 17.7.–18.7. | Viet Nam, China | Tropical storm Talas | 14 dead<br>5 000 homeless<br>USD 80m total damage |
| 21.7.–23.7. | United States<br>IL, KS, MO | Thunderstorms, large hail | USD 300m–600m insured loss<br>USD 600m total damage |
| 23.7. | Canada<br>Wetaskiwin, Red Deer, Edmonton, Calgary, Bashaw, Camrose, AB | Thunderstorms, heavy rains, flash floods | CAD 71m (USD 56m) insured loss<br>CAD 100m (USD 80m) total damage |
| 26.7.–29.7. | China<br>Yulin City, Shaanxi Province | Rainstorms and floods – 900 houses destroyed, 17 300 houses damaged, 8600 ha of cropland destroyed, 39 400 ha of crops flooded | 8 dead, 1 missing<br>76 800 homeless<br>CNY 3.2bn (USD 492m) total damage |
| 5.8.–8.8. | United States<br>TX, OK, LA, KS, MO | Thunderstorms, large hail, flash floods, tornadoes | USD 100m–300m insured loss<br>USD 200m total damage |
| 6.8.–10.8. | Italy | Thunderstorms, hail, flash floods | EUR 140m (USD 168m) insured loss |
| 7.8. | Japan<br>Kyushu, Tohoku | Typhoon Noru – 2 houses destroyed, 222 houses damaged, 354 houses flooded | 2 dead<br>51 injured<br>JPY 10bn (USD 88m) insured loss |
| 10.8.–12.8. | Poland, Czech Republic, Slovakia | Thunderstorms and derecho winds – severe damage to forests in Poland | 6 dead<br>50 injured<br>EUR 60m (USD 72m) insured loss |
| 23.8. | China, Viet Nam, Hong Kong<br>Macau | Typhoon Hato, storm surge along the coast of Pearl River estuary | 26 dead, 1 missing<br>376 injured<br>USD 1.1bn insured loss<br>USD 4.8bn total damage |
| 25.8.–1.9. | United States<br>Landfall in Corpus Christi, second in Louisiana | Hurricane Harvey (Cat 4), severe inland flood in Houston – 200 000 houses flooded, 30 000 people displaced, explosions at flooded chemical plant in Crosby | 89 dead<br>USD 30 bn insured loss<br>USD 85bn total damage |
| 6.9.–12.9. | United States, Cuba, Virgin Islands (British), Turks and Caicos Islands, Antigua and Barbuda, Anguilla, Barbados, Netherlands Antilles, Saint Kitts and Nevis | Hurricane Irma | 126 dead<br>USD 30bn insured loss<br>USD 67bn total damage |
| 11.9.–16.9. | Viet Nam, Philippines, China | Typhoon Doksuri | 22 dead, 4 missing<br>112 injured<br>USD 600m total damage |
| 17.9.–18.9. | Japan, Philippines<br>Okinawa, Hokkaido | Typhoon Talim | 27 dead, 4 missing<br>59 injured<br>USD 268m insured loss<br>USD 812m total damage |
| 17.9. | Rwanda<br>Rusizi, Nyamasheke, Huye and Bugesera, Gicumbi, Ngoma, Kirehe, Rubavu and Nyabihu | Thunderstorms, heavy rains | 3 dead<br>24 injured<br>2 200 homeless |
| 19.9.–21.9. | United States, Dominica, Trinidad and Tobago, Guadeloupe, Martinique, Dominican Republic | Hurricane Maria | 101 dead, 35 missing<br>USD 32bn insured loss<br>USD 65bn total damage |
| 24.9.–27.9. | Hong Kong, China | Tropical Storm Pakhar | 12 dead<br>72 injured<br>USD 45m insured loss<br>CNY 760m (USD 117m) total damage |

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 1.10.–5.10. | China<br>Sichuan, Chongqing, Anhui, Henan, Hubei, Shaanxi | Thunderstorms, floods – 5200 houses destroyed | 23 dead<br>CNY 490m (USD 75m) total damage |
| 5.10. | Germany, Poland, Czech Republic, Netherlands | Windstorm Xavier | 9 dead<br>63 injured<br>EUR 350m (USD 420m) insured loss |
| 7.10.–8.10. | United States, Costa Rica, Panama, Nicaragua, El Salvador, Honduras, Guatemala | Hurricane Nate | 31 dead, 19 missing<br>USD 128m insured loss<br>USD 500m total damage |
| 9.10.–10.10. | South Africa<br>Durban | Thunderstorms, large hail, flash floods | ZAR 1bn (USD 81m) insured loss<br>ZAR 2.7bn (USD 218m) total damage |
| 14.10.–15.10. | United States<br>IL, MO, KS | Thunderstorms, large hail, flash floods | USD 100m–300m insured loss |
| 16.10.–17.10. | Ireland, United Kingdom | Remnants of Hurricane Ophelia bring wind damage | USD 73m insured loss<br>USD 105m total damage |
| 16.10.–18.10. | Canada<br>Calgary, Medicine Hut, Regina, Moose Jaw, Saskatoon, Winnipeg, Dauphin | Windstorm in British Columbia and Prairies | CAD 109m (USD 87m) insured loss<br>CAD 140m (USD 112m) total damage |
| 18.10. | Philippines, Japan | Remnants of Typhoon Lan (Paolo) | 2 500 homeless<br>USD 888m insured loss<br>USD 2.6bn total damage |
| 23.10.–24.10. | United States<br>NC, SC | Thunderstorms, flash floods | USD 25m–100m insured loss<br>USD 120m total damage |
| 29.10. | Germany, Austria, Denmark, Poland, Czech Republic, Slovakia, Hungary | Windstorm Herwart | 8 dead<br>USD 390m insured loss |
| 29.10.–30.10. | United States, Canada<br>US: MA, ME, RI, CT, NH, NY, VT, CA: Kingston, Ottawa, ON; Gatineau, Wakefield, QC | Remnants of post tropical storm Philippe bring strong wind and flood damage | USD 300m–600m insured loss<br>USD 612m total damage |
| 2.11.–6.11. | Viet Nam, Philippines, Malaysia | Typhoon Damrey | 123 dead<br>USD 1.008bn total damage |
| 5.11.–6.11. | United States<br>OH, MO | Thunderstorms, hail | USD 100m–300m insured loss<br>USD 260m total damage |
| 29.11.–2.12. | India, Sri Lanka<br>Kerala, Tamil Nadu, Maharashtra | Cyclone Ockhi – many fishermen caught in heavy seas | 63 injured |
| 11.12. | South Africa<br>Midvaal, Gauteng | Tornado damages 550 homes | 50 injured<br>300 homeless |
| 16.12.–18.12. | Philippines<br>Mimaropa, Mindoro, Palawan, Region VIII | Tropical storm Kai-tak triggers flooding – 5535 houses destroyed, 28 538 houses damaged | 47 dead, 44 missing<br>78 injured<br>PHP 2.825bn (USD 57m) total damage |
| 19.12. | Australia<br>Melbourne, VIC | Thunderstorms, large hail, heavy rains, flash floods in Melbourne – hail damage to vehicles | AUD 378m (USD 296m) insured loss<br>AUD 450m (USD 352m) total damage |
| 22.12.–24.12. | Philippines<br>Davao Oriental, Lanao del Norte, Misamis Oriental, Misamis Occidental, Zamboanga del Norte, Balabac, Palawan | Tropical storm Tembin (Vinta) triggers flooding – 4179 houses destroyed, 5182 houses damaged | 168 dead, 163 missing<br>19 369 homeless<br>PHP 2.345bn (USD 47m) total damage |

## Earthquakes

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 18.1. | Italy<br>Farindola | Series of earthquakes Mw 5.7, avalanche buries hotel – rescue efforts hindered by snow storm | 34 dead<br>11 injured<br>EUR 5m (USD 6m) insured loss<br>EUR 15m (USD 18m) total damage |
| 10.2. | Philippines<br>Offshore 16 km from Surigao City, Mindanao | Earthquake Mw 6.7 (aftershock of My 5.9) – 555 houses destroyed, 9775 houses damaged | 8 dead<br>249 injured<br>PHP 2bn (USD 40m) total damage |
| 26.3. | China<br>Yangbi, Yunnan | Earthquake Mw 5.0 | 1 injured<br>2 105 homeless<br>CNY 202m (USD 31m) total damage |
| 4.4.–16.4. | Philippines<br>Mabini, Batangas | Series of earthquakes – 579 houses destroyed, 2660 houses damaged | 6 dead<br>3 528 homeless |
| 10.5. | China, Tajikistan<br>Epicentre: Murghob, Tajikistan; China: Taxkorgan | Earthquake Mw 5.5 – 3015 houses destroyed | 8 dead<br>23 injured<br>9 200 homeless |
| 13.5. | Iran<br>Bojnurd, North Khorasan | Earthquake Mw 5.8 | 2 dead<br>370 injured |
| 6.7. | Philippines<br>Ormoc City, Leyte | Earthquake Mw 6.5 – 735 houses destroyed, 1029 houses damaged | 2 dead<br>220 injured<br>USD 5m total damage |
| 21.7. | Greece, Turkey<br>Gokova Bay | Earthquake Mw 6.6 triggers tsunami over parts of Bodrum south coast and Kos island | 2 dead<br>190 injured |
| 8.8. | China<br>Zhangzha Town, Ngawa Prefecture, Sichuan Province | Earthquake Mw 6.5 – 40 000 houses damaged | 25 dead<br>525 injured |
| 7.9. | Mexico, Guatemala<br>Pijijiapan, Chiapas, Oaxaca | Earthquake Mw 8.1 – 47 468 houses destroyed, 94 027 houses damaged | 98 dead<br>251 injured<br>USD 400m insured loss<br>USD 4bn total damage |
| 19.9. | Mexico<br>Atencingo, Puebla | Earthquake Mw 7.1 – 184 000 houses damaged | 369 dead<br>6,000 injured<br>USD 1.2bn insured loss<br>USD 8bn total damage |
| 12.11. | Iran, Iraq<br>Epicentre: 30 km South of Halabjah, Iraq | Earthquake Mw 7.3 on the Iran-Iraq border – 30 000 houses damaged | 630 dead<br>9 947 injured<br>IRR 300bn (USD 8m) insured loss<br>IRR 26 000bn (USD 721m) total damage |

## Drought, bush fires, heat waves

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 15.1.–28.1. | Chile<br>Biobio, La Araucania, Los Lagos, Maule, Metropolitana, O'Higgings, Valparaiso | Wildfires – 1103 houses destroyed, 467 537 ha of forest burnt, 92 ha of vineyards burnt | 11 dead<br>30 injured<br>USD 100m insured loss<br>USD 370m total damage |
| 1.3.–31.12. | Somalia, Ethiopia, Kenya | Drought | USD 1bn total damage |
| 12.4.–15.6. | India | Heatwave | 264 dead |
| 6.6.–10.6. | South Africa<br>Knysna | Wildfires fuelled by winds of winter storm and triggered by an electrical spark – 600 buildings destroyed | 9 dead<br>USD 178m insured loss<br>USD 364m total damage |
| 17.6.–18.6. | Portugal<br>Pedrógão Grande, Castanheira de Pera, Figueiró dos Wines | Wildfires – 320 houses damaged, 45 328 ha of forest burnt | 65 dead<br>160 injured<br>EUR 16m (USD 19m) insured loss<br>EUR 193m (USD 232m) total damage |
| 18.6.–22.6. | France, Italy, Serbia and Montenegro, Spain, Croatia | Drought in Europe | EUR 300m (USD 360m) insured loss<br>EUR 3.2bn (USD 3.843bn) total damage |
| 15.7.–27.7. | Canada<br>William Lake, BC | Williams Lake wildfires | CAD 89m (USD 71m) insured loss<br>CAD 100m (USD 80m) total damage |
| 8.10.–20.10. | United States<br>Santa Rosa (Sonoma County), Napa County | Wildland fire "Tubbs Fires" – 5643 structures destroyed, 14 895 ha of forest burnt, damage to wineries and vineyards | 22 dead<br>USD 7.71bn insured loss<br>USD 9.5bn total damage |
| 8.10.–20.10. | United States<br>Napa County, Solano County, CA | Wildland fire "Atlas fire" – 481 structures destroyed, 90 damaged, damage to wineries and vineyards , 20 891 ha of forest burnt | 6 dead<br>USD 2.666bn insured loss<br>USD 3.2bn total damage |
| 8.10.–20.10. | United States<br>Mendocino County, CA | Wildland fire "Mendocino Lake Complex" – 545 destroyed, 43 damaged, 14 780 ha of land burnt | 9 dead<br>USD 587m insured loss<br>USD 800m total damage |
| 15.10.–16.10. | Portugal, Spain<br>Portugal: Viseu, Coimbra;<br>Spain: Galicia | Wildfires | 49 dead<br>71 injured<br>EUR 269m (USD 323m) insured loss<br>EUR 1.329bn (USD 1.596bn) total damage |
| 4.12.–23.12. | United States<br>Ventura County, Santa Barbara County, CA | Wildland fire "Thomas Fire" (Santa Ana winds) – 1063 structures destroyed, 114 078 ha of forest burnt (largest fire in California's history) | USD 2.27bn insured loss |
| 5.12.–12.12. | United States<br>Sylmar, CA | Wildland fire "Creek Fire" (Santa Ana winds) – 60 residential and 63 outbuildings destroyed, 55 residential and 26 outbuildings damaged, 708 ha of forest burnt | USD 100m–300m insured loss<br>USD 310m total damage |
| 7.12.–12.12. | United States<br>San Diego County, CA | Wildland fire "Lilac Fire" (Santa Ana winds)- 157 structures destroyed, 64 damaged, 1659 ha of forest burnt | USD 100m–300m insured loss<br>USD 130m total damage |

## Cold, frost

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 5.1.–10.1. | Poland, Italy, Czech Republic, Greece, Serbia, Macedonia – Republic of, Slovakia, Albania, Romania, Ukraine, Belarus | Cold spell in Europe with temperatures minus 30 – heavy snowfall | 123 dead<br>539 injured |
| 16.1.–22.1. | Italy | Heavy snow fall, icy winds, freeze | 3 dead<br>EUR 90m (USD 108m) insured loss |
| 22.1.–25.1. | Afghanistan<br>Jawzjan Province | Cold spell | 27 dead |
| 14.3.–16.4. | United States<br>SC, GA, NC, TN, AL, MS, FL, KY, VA | Severe frost damages crops in the South East | USD 1bn total damage |
| 19.4.–24.4. | Germany, Austria, Italy, France, Switzerland, Spain, Croatia, Slovenia, Romania, Ukraine, Serbia | Cold spell brings frost damage in Europe – severe damage to agriculture | EUR 775m (USD 930m) insured loss<br>EUR 3.405bn (USD 4.089bn) total damage |

## Hail

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 18.2. | Australia<br>Sydney, Illawarra | Hailstorm (Sydney storm) | USD 400m insured loss<br>USD 470m total damage |
| 26.3.–28.3. | United States<br>TX, OK, AL, TN, KY, MS | Hailstorm, thunderstorms, tornadoes | USD 1bn – 3bn insured loss<br>USD 2.4bn total damage |
| 8.5.–11.5. | United States<br>Denver, CO, NM, OK, TX, MO | Hailstorm, thunderstorms, tornadoes, severe hail damage in Denver, CO | USD 1bn – 3bn insured loss<br>USD 3.4bn total damage |
| 11.6. | United States<br>Minneapolis, MN, WI | Hail storm in Minnesota | USD 1 bn – 3bn insured loss |
| 22.6.–23.6. | Germany, Hungary | Hailstorm Paul and Rasmund – severe damage to agriculture | EUR 600m (USD 721m) insured loss |
| 24.6.–28.6. | Italy | Hailstorms, thunderstorms, flash floods | EUR 110m (USD 132m) insured loss |
| 21.7.–27.7. | Switzerland<br>North | Hailstorms | CHF 86m (USD 88m) insured loss<br>CHF 100m (USD 103m) total damage |
| 27.7. | Turkey<br>Istanbul | Hailstorm, thunderstorms, flash flooding – damage to a landing plane and to vehicles | 10 injured<br>TRY 700m (USD 185m) insured loss |

## Other natural catastrophes

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 25.1. | India<br>Ganderbal, Bandipora<br>(Jammu and Kashmir) | Avalanches bury civilians in a home and soldiers in an army camp | 24 dead |
| 29.4. | Kyrgyzstan<br>Ayu, Uzgen District, Osh | Heavy rains and snow melt trigger landslide – 11 houses destroyed | 24 dead |
| 24.6. | China<br>Xinmo, Maoxian County, Sichuan | Landslide – 40 houses destroyed | 10 dead, 73 missing |
| 13.8. | India<br>Kotropi, Mandi District, HP | Massive landslide buries houses, two buses and other vehicles | 47 dead |
| 14.8. | Sierra Leone<br>Regent, Freetown | Heavy rains trigger flood and massive landslide and debris flow in Babadorie River Valley – 349 buildings destroyed, 552 buildings damaged | 1 141 dead<br>3 000 homeless |
| 16.8. | Congo, Democratic Republic of (DRC) | Landslide | 200 dead |
| 16.12. | Chile<br>Villa Santa Lucía, Los Lagos | Heavy rains trigger mudslide that buries village | 18 dead, 4 missing |

Table 8 uses loss ranges for US natural catastrophes as defined by Property Claims Services. For Canada loss estimates, the data is from CatIQ.
Source: Swiss Re Institute and Cat Perils.

**Table 9**
Chronological list of all man-made disasters 2017

## Aviation disasters

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 16.1. | Kyrgyzstan<br>Biskek | THY Turkish Airlines Boeing 747-412F cargo plane crashes on village on landing | 39 dead |
| 14.3. | Ireland | Irish coast guard CHC S-92 helicopter crash | 2 dead, 2 missing |
| 7.6. | Myanmar (Burma) | Myanmar Air Force Shaanxi Y-8-200F transport plane crashes on sea in adverse weather | 122 dead |
| 18.6. | Space | Chinasat 9A satellite delivered to wrong orbit due to launch failure | |
| 18.11. | United Kingdom<br>Bedfordshire | Airlander 10 airship breaks free from its mooring and sustains damage | |
| 28.11. | Space | Soyuz 2-1B Fregat launch failure leads to loss of main mission satellite and 18 smaller co-passenger satellites | |
| 8.12. | Qatar<br>Doha | Qatar Airways Airbus A321 catches fire while on ground | |

## Major fires, explosions

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 2.1. | Ivory Coast<br>Abidjan | Fire and explosion at a refinery | |
| 9.1. | United States<br>Louisiana | Fire at a petrochemical company | |
| 11.1. | United Arab Emirates<br>Ruwais | Fire at a refinery | |
| 19.1. | Iran<br>Tehran | 17-storey building catches fire due to an electrical short-circuit and collapses | 26 dead<br>180 injured |
| 20.1. | Russia<br>Bashkortostan | Fire at a refinery | |
| 22.1. | Japan<br>Wakayama Prefecture | Fire at a refinery storage tank | |
| 22.1. | Czech Republic<br>Písek | Fire at an automotive equipment factory | |
| 29.1. | United States<br>Pittsburg, CA | Fire at a gas power station | |
| 30.1. | Finland<br>Pori | Fire at a titanium dioxide manufacturing facility | |
| 1.2. | Philippines<br>Cavite, Manila | Fire at an export facility factory | 1 dead<br>126 injured |
| 7.2. | Philippines<br>Manila | Fire at a shanty town – 1000 makeshift houses destroyed | 7 injured<br>15 000 homeless |

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 8.2. | China<br>Tianjin | Fire at an electronics plant | |
| 25.2. | United States<br>Longview, TX | Vapour cloud explosion at a chemical plant | 4 dead<br>60 injured |
| 7.3. | Guatemala<br>Guatemala City | Fire at a children's home | 40 dead |
| 14.3. | Canada<br>Fort McMurray | Fire at a refinery | 1 injured |
| 24.3. | South Africa<br>Durban | Fire at a container warehouse | |
| 2.4. | United Arab Emirates<br>Dubai | Fire at a 72-storey residential buildings | |
| 5.4. | Mexico<br>Puerto Manzanillo | Fire at a thermal power plant | |
| 12.4. | Senegal<br>Medina Gounass | Fire at a makeshift shelter during religious festival triggers stampede | 22 dead |
| 26.4. | United Kingdom<br>Salford, Manchester | Fire at a University research hospital | |
| 27.4. | Colombia<br>Cartagena | Six-storey building collapses while under construction | 20 dead<br>20 injured |
| 10.5. | India<br>Bharatpur, Rajasthan | Wall of wedding hall collapses | 26 dead<br>28 injured |
| 14.5. | Philippines<br>Clark Freeport | Fire at a tire plant | 1 injured |
| 28.5. | India<br>Korba, Chhattisgarh | Fire at a power plant | 7 injured |
| 7.6. | India<br>Balaghat | Explosion at a firecracker factory | 23 dead<br>10 injured |
| 14.6. | United Kingdom<br>London | Fire at a residential 24-storey building – fire started in a faulty fridge freezer | 71 dead, 9 missing<br>74 injured |
| 24.7. | Denmark<br>Kalundborg | Explosion at an oil refinery | |
| 25.7. | India<br>Mumbai | Six-storey residential building collapses | 30 dead |
| 4.8. | Oman | Incident at an aluminium factory | |
| 10.8. | South Korea<br>Yeosu | Fire at an oil refinery | |
| 30.8. | Romania<br>Timisoara | Fire at a machine casting plant | |
| 31.8. | India<br>Mumbai | Residential building collapses | 33 dead |
| 7.9. | United States<br>Charleston, TN | Explosion and leak at a chemicals plant | 2 injured |
| 11.9. | Canada<br>Fort McMurray | Fire at an oil sand plant | 1 injured |
| 14.9. | Malaysia<br>Kuala Lumpur | Fire at a school | 24 dead |
| 23.9. | China<br>Macau | Fire at a gaming resort palace under construction | |
| 4.10. | United States<br>Kingsport, TN | Fire and explosion at a petrochemical plant | |

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 8.10. | Russia<br>Moscow | Fire at a shopping mall | |
| 26.10. | Indonesia<br>Jakarta | Explosions and fire at a fireworks factory | |
| 31.10. | Germany<br>Ludwigshafen | Fire and explosion at a chemicals plant | 48 dead<br>46 injured |
| 1.11. | India<br>Unchahar, Rae Bareli district, Uttar Pradesh | Explosion at a coal-fired power plant | 32 dead<br>100 injured |
| 20.11. | United States<br>New Windsor, NY | Explosions at a cosmetics factory | 1 dead<br>125 injured |
| 1.12. | China<br>Jimo district, Qingdao, Shandong province | Fire at a warehouse | |
| 21.12. | South Korea<br>Jecheon | Fire at an eight-storey residential building | 29 dead<br>29 injured |
| 23.12. | Philippines<br>Davao City, Mindanao | Fire at a shopping mall | 38 dead |

## Maritime disasters

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 1.1. | Indonesia<br>Jakarta | Passenger ferry catches fire and suffers explosion | 23 dead<br>50 injured |
| 14.1. | India<br>Patna, Bihar | Overload wooden boat sinks on the Ganges River | 24 dead |
| 14.1. | Mediterranean Sea | Boat carrying migrants capsizes off Libya | 8 dead, 92 missing |
| 18.1. | Kiribati<br>Nonouti | Passenger ferry sinks | 88 dead |
| 11.2. | Mozambique<br>Quelimane | Boat capsizes on Chipaca River | 1 dead, 20 missing |
| 18.2. | Philippines<br>Cebu, Mactan Channel | Three vessels collide | 58 injured |
| 19.2. | Libyan Arab Jamahiriya<br>Zawiyah | Boat carrying migrants sink – 74 bodies found ashore | 74 dead |
| 23.2. | Gulf of Oman<br>Fujairah | A tanker carrying gas collides with oil tanker | |
| 31.3. | South Atlantic | Ore carrier goes missing in the South Atlantic | 22 dead |
| 5.4. | Myanmar (Burma)<br>Pathein | Ferry collides with a river barge in Irrawaddy Delta | 20 dead |
| 24.4. | Senegal<br>Bettenty | Tourist wooden boat capsizes | 21 dead |
| 25.4. | Nigeria<br>Akwa Ibom State | Fire on an oil rig | |
| 24.5. | Libyan Arab Jamahiriya<br>Zouara | Boat carrying migrants capsizes | 34 dead |
| 10.6. | Mediterranean Sea | Boat carrying migrants capsizes | 10 dead, 100 missing |
| 25.6. | Colombia<br>Guatapé reservoir, Medellin | Passenger ferry capsizes on Guatapé reservoir | 9 dead, 28 missing |

| Date | Country | Event | Number of victims and amount of damage (where data available), in local currency and/or USD |
|---|---|---|---|
| 29.6. | Mediterranean Sea | Boat carrying migrants capsizes | 60 missing |
| 2.7. | Mediterranean Sea | Boat carrying migrants capsizes | 35 dead |
| 11.7. | South Pacific Ocean<br>New Caledonia | Containership runs aground | |
| 22.8. | Brazil<br>Para | Boat sinks on Xingu River | 21 dead |
| 22.8. | Brazil<br>Pará | Passenger boat capsizes | 21 dead, 5 missing |
| 24.8. | Brazil<br>Salvador | Ferry capsizes | 18 dead, 3 missing |
| 24.8. | Brazil<br>Bahia | Passenger boat capsizes | 22 dead |
| 14.9. | India<br>Baghpat district, Uttar Pradesh | Boat capsizes on Yamuna River | 22 dead |
| 15.9. | Nigeria | Passenger boat capsizes | 33 dead, 23 missing |
| 20.9. | Mediterranean Sea<br>Sabratha | Boat carrying migrants capsizes | 50 dead |
| 22.9. | Black Sea<br>Kefken | Fishing boat capsizes | 21 dead, 5 missing |
| 28.9. | Bangladesh | Boat carrying migrants fleeing Myanmar capsizes | 23 dead, 40 missing |
| 2.10. | Nigeria | Passenger ferry capsizes on River Niger | 17 dead, 26 missing |
| 8.10. | Bangladesh | Boat carrying migrants capsizes | 12 dead, 28 missing |
| 8.10. | Mediterranean Sea<br>Kerkennah | Tunisian military ship collides with vessel carrying migrants | 8 dead, 20 missing |
| 12.11. | India<br>Ibrahimpatnam Mandal | Boat carrying tourists capsizes on Krishna River | 16 dead, 7 missing |
| 25.11. | Mediterranean Sea | Boat carrying migrants capsizes | 31 dead |
| 23.12. | Tanzania<br>Uvinza District | Two motor vessels collide on Lake Tanganyika | 19 dead, 3 missing |

## Mining accidents

| Date | Country | Event | Number of victims (where data available) |
|---|---|---|---|
| 3.5. | Iran<br>Azadshahr | Explosion at a coal mine | 42 dead<br>80 injured |
| 2.7. | Ghana<br>Prestea-Nsuta | Gold mine collapses | 22 dead |

## Rail disasters (incl. cableways)

| Date | Country | Event | Number of victims (where data available) |
|---|---|---|---|
| 4.1. | United States<br>New York | Commuter train derails | 103 injured |
| 21.1. | India<br>Kuneru, Vizianagaram (AP) | Passenger train derails | 41 dead<br>68 injured |
| 30.3. | India<br>Kulpahar, Mahoba, UP | Passenger train derails | 52 injured |
| 28.7. | Spain<br>Barcelona | A commuter train crashes into platform | 54 injured |
| 11.8. | Egypt<br>Alexandria | Two trains collide | 41 dead<br>130 injured |
| 19.8. | India<br>Khatauli, Muzaffarnagar, UP | Passenger train derails | 22 dead<br>156 injured |
| 23.8. | India<br>Auraiya district | Ten coaches of a passenger train derail after crashing into a dumper on the tracks | 100 injured |
| 13.11. | Congo, Democratic Republic of (DRC)<br>Buyofwe | Train derails and catches fire | 33 dead<br>23 injured |
| 5.12. | Germany<br>Meerbusch,<br>North Rhine-Westphalia | Passenger train collides with a freight train | 50 injured |
| 18.12. | United States<br>Washington | Passenger train derails while approaching a highway overpass damaging 14 highway vehicles | 3 dead<br>62 injured |

## Miscellaneous

| Date | Country | Event | Number of victims (where data available) |
|---|---|---|---|
| 1.1. | Turkey<br>Istanbul | Mass shooting at a night club | 39 dead<br>70 injured |
| 8.1.–12.1. | Mexico | Riots over the price of petrol | |
| 20.1. | Pakistan<br>Parachinar | Bomb explosion at a food market | 25 dead<br>87 injured |
| 10.2. | Angola<br>Uíge | Stampede at a football stadium | 17 dead<br>61 injured |
| 13.2. | Pakistan<br>Lahore | Suicide bomb explosion during a mass protest | 18 dead<br>91 injured |
| 16.2. | Pakistan<br>Sehwan | Suicide bomb explosion at a religious shrine | 91 dead<br>300 injured |
| 11.3. | Ethiopia<br>Addis Ababa | Garbage dump collapses on a slum | 113 dead |
| 31.3. | Pakistan<br>Parachinar | Car bomb explosion outside a mosque | 24 dead<br>70 injured |
| 3.4. | Russia<br>St Petersburg | Suicide bomb explosion at a St Petersburg metro station | 15 dead<br>64 injured |
| 9.4. | Egypt<br>Tanta, Alexandria | Coordinated suicide bomb explosions at 2 churches during Palm Sunday Mass | 47 dead<br>126 injured |
| 14.4. | Sri Lanka<br>Colombo | Garbage dump collapses on slum – 40 houses destroyed, 104 houses damaged | 32 dead |
| 9.5. | Thailand<br>Pattani | Two bomb explosions outside a supermarket | 80 injured |
| 22.5. | United Kingdom<br>Manchester | Suicide bomb explosion outside concert hall | 22 dead<br>116 injured |
| 3.6. | Italy<br>Turin | Stampede during celebrations for sport | 1 dead<br>1 500 injured |
| 23.6. | Pakistan<br>Parachinar | Two bomb explosions at a food market | 72 dead<br>200 injured |
| 15.7. | Senegal<br>Dakar | Stampede at a football stadium | 8 dead<br>60 injured |
| 27.8. | United Kingdom<br>East Sussex | Gas cloud at Birling Gap beach | 150 injured |
| 29.9. | India<br>Mumbai | Stampede at a train station during morning rush hour | 23 dead<br>39 injured |
| 1.10. | United States<br>Las Vegas | Mass shooting at a an open air music festival | 58 dead<br>514 injured |
| 24.11. | Egypt<br>Sinai | Bomb explosion at a mosque | 311 dead<br>122 injured |
| 17.12. | Pakistan<br>Quetta, Balochistan | Two suicide bomb explosions at a church during mass service | 9 dead<br>57 injured |

**Table 10**
The 40 most costly insurance losses (1970–2017)

| Insured loss[36] (in USD mn, indexed to 2017) | Victims[37] | Start date | Event | Country/region |
|---|---|---|---|---|
| 82 394 | 1 836 | 25.8.2005 | Hurricane Katrina, storm surge, damage to oil rigs | US, Gulf of Mexico |
| 38 128 | 18 451 | 11.3.2011 | Earthquake (Mw 9.0) triggers tsunami | Japan |
| 32 000 | 136 | 19.9.2017 | Hurricane Maria | US, Puerto Rico, US Virgin Island, Caribbean |
| 30 774 | 237 | 24.10.2012 | Hurricane Sandy, storm surge | US, Caribbean, Canada |
| 30 000 | 126 | 6.9.2017 | Hurricane Irma | US, Puerto Rico, US Virgin Island, Caribbean |
| 30 000 | 89 | 25.8.2017 | Hurricane Harvey | US |
| 27 943 | 65 | 23.8.1992 | Hurricane Andrew, storm surge | US, Bahamas |
| 25 991 | 2 982 | 11.9.2001 | Terror attack on WTC, Pentagon, other buildings | US |
| 25 293 | 61 | 17.1.1994 | Northridge earthquake (Mw 6.7) | US |
| 23 051 | 193 | 6.9.2008 | Hurricane Ike, floods, damage to oil rigs | US, Caribbean, Gulf of Mexico |
| 19 070 | 185 | 22.2.2011 | Earthquake (Mw 6.1), aftershocks | New Zealand |
| 16 762 | 119 | 2.9.2004 | Hurricane Ivan, damage to oil rigs | US, Caribbean, Venezuela |
| 16 341 | 815 | 27.7.2011 | Heavy monsoon rains, extreme flooding | Thailand |
| 15 771 | 53 | 19.10.2005 | Hurricane Wilma, torrential rains, flooding | US, Mexico, Caribbean |
| 13 476 | 34 | 20.9.2005 | Hurricane Rita, storm surge, damage to oil rigs | US, Gulf of Mexico |
| 11 740 | 123 | 15.7.2012 | Drought in the Corn Belt | US |
| 10 244 | 36 | 11.8.2004 | Hurricane Charley | US, Caribbean, Gulf of Mexico |
| 10 159 | 51 | 27.9.1991 | Typhoon Mireille/No. 19 | Japan |
| 9 038 | 78 | 15.9.1989 | Hurricane Hugo | US, Caribbean |
| 8 989 | 562 | 27.2.2010 | Earthquake (Mw 8.8) triggers tsunami | Chile |
| 8 757 | 95 | 25.1.1990 | Winter storm Daria | France, UK, Belgium, NL et. al. |
| 8 655 | – | 4.9.2010 | Earthquake (Mw 7.0), over 300 aftershocks | New Zealand |
| 8 532 | 110 | 25.12.1999 | Winter storm Lothar | Switzerland, UK, France, et. al. |
| 7 952 | 321 | 22.4.2011 | Major tornado outbreak; 349 tornadoes, hail | US |
| 7 710 | 22 | 8.10.2017 | Wildland fire "Tubbs Fires" | US |
| 7 680 | 177 | 20.5.2011 | Tornado outbreak, winds up to 405 km/h, hail | US |
| 7 205 | 54 | 18.1.2007 | Winter storm Kyrill, floods | Germany, UK, NL, Belgium et. al. |
| 6 684 | 22 | 15.10.1987 | Storm and floods in Europe | France, UK, NL, et. al. |
| 6 523 | 50 | 26.8.2004 | Hurricane Frances, storm surge | US, Bahamas |
| 6 190 | 51 | 22.8.2011 | Hurricane Irene, floods | US, Canada, Caribbean |
| 6 081 | 45 | 6.9.2004 | Typhoon Songda/No. 18 | Japan, South Korea |
| 5 942 | 26 | 22.9.1999 | Typhoon Bart/No 18 | Japan |
| 5 815 | 600 | 20.9.1998 | Hurricane Georges, floods | US, Caribbean |
| 5 649 | 64 | 25.2.1990 | Winter storm Vivian | Switzerland, Germany |
| 4 998 | 3 034 | 13.9.2004 | Hurricane Jeanne; floods | US, Caribbean |
| 4 992 | 43 | 5.6.2001 | Tropical storm Allison; heavy rain, floods | US |
| 4 990 | 137 | 14.4.2016 | Earthquakes | Japan |
| 4 349 | 26 | 27.5.2013 | Floods | Germany, Czech Republic, et. al. |
| 4 268 | 51 | 2.5.2003 | Thunderstorms, tornadoes, hail, flash floods | US |
| 4 152 | 78 | 10.9.1999 | Hurricane Floyd, heavy rain, floods | US, Bahamas |

Note: Mw = moment magnitude scale.
Source: Swiss Re Institute and Cat Perils.

[36] Property and business interruption, excluding liability and life insurance losses;
US natural catastrophe figures based on Property Claim Services (PCS)/incl. NFIP losses (see "Terms and selection criteria" on page 50).
[37] Dead and missing.

**Table 11**
The 40 worst catastrophes in terms of victims (1970–2017)

| Victims [38] | Insured loss[39] (in USD mn, indexed to 2017) | Start date | Event | Country/region |
|---|---|---|---|---|
| 300 000 | – | 11.11.1970 | Storm and flood catastrophe | Bangladesh |
| 255 000 | – | 28.07.1976 | Earthquake (Mw 7.6) | China |
| 222 570 | 112 | 12.01.2010 | Earthquake (Mw 7.0), aftershocks | Haiti |
| 220 000 | 2 594 | 26.12.2004 | Earthquake (Mw 9) triggers tsunami in Indian Ocean | Indonesia, Thailand, et. al. |
| 138 373 | – | 02.05.2008 | Tropical cyclone Nargis, Irrawaddy Delta flooded | Myanmar, Bay of Bengal |
| 138 000 | 4 | 29.04.1991 | Tropical cyclone Gorky | Bangladesh |
| 87 449 | 417 | 12.05.2008 | Earthquake (Mw 7.9) in Sichuan | China |
| 74 310 | – | 08.10.2005 | Earthquake (Mw 7.6); aftershocks, landslides | Pakistan, India, Afghanistan |
| 66 000 | – | 31.05.1970 | Earthquake (Mw 7.9) triggers rock slide and floods | Peru |
| 55 630 | – | 15.06.2010 | Heat wave, temperatures of up to 40°C | Russia, Czech Republic |
| 40 000 | 216 | 20.06.1990 | Earthquake (Mw 7.4), landslides | Iran |
| 35 000 | 1 680 | 01.06.2003 | Heat wave and drought in Europe | France, Italy, Germany, et. al. |
| 26 271 | – | 26.12.2003 | Earthquake (Mw 6.5) destroys 85% of Bam | Iran |
| 25 000 | – | 07.12.1988 | Earthquake (Mw 6.8) | Armenia |
| 25 000 | – | 16.09.1978 | Earthquake (Mw 7.7) in Tabas | Iran |
| 23 086 | – | 13.11.1985 | Volcanic eruption on Nevado del Ruiz triggers lahars | Colombia |
| 22 300 | 323 | 04.02.1976 | Earthquake (Mw 7.5) | Guatemala |
| 19 737 | 138 | 26.01.2001 | Earthquake (Mw 7.6) in Gujarat | India, Pakistan |
| 19 118 | 1 471 | 17.08.1999 | Earthquake (Mw 7.6) in Izmit | Turkey |
| 18 451 | 38 128 | 11.03.2011 | Earthquake (Mw 9.0) triggers tsunami | Japan |
| 15 000 | 147 | 29.10.1999 | Tropical cyclone 05B in Orissa | India |
| 14 204 | – | 20.11.1977 | Tropical cyclone in Andhra Pradesh | India |
| 11 683 | 601 | 22.10.1998 | Hurricane Mitch in Central America | Honduras, Nicaragua, et. al. |
| 11 069 | – | 25.05.1985 | Tropical cyclone in Bay of Bengal | Bangladesh |
| 10 800 | – | 26.10.1971 | Odisha cyclone, flooding in Bay of Bengal | India |
| 10 000 | 324 | 12.12.1999 | Floods, mudflows and landslides | Venezuela |
| 9 500 | 547 | 19.09.1985 | Earthquake (Mw 8.0) | Mexico |
| 9 475 | | 30.09.1993 | Earthquake (Mw 6.4) | India |
| 8 960 | 165 | 25.04.2015 | Earthquake (Mw 7.8) | Nepal, India, China, Bangladesh |
| 8 135 | 536 | 08.11.2013 | Typhoon Haiyan, storm surge | Philippines, Vietnam, China, Palau |
| 7 079 | – | 17.08.1976 | Earthquake (Mw 7.1) triggers tsunami in Moro Gulf | Philippines |
| 6 434 | 3 975 | 17.01.1995 | Great Hanshin (Mw 6.9) earthquake in Kobe | Japan |
| 6 304 | – | 05.11.1991 | Typhoon Thelma (Uring) | Philippines |
| 6 000 | – | 02.12.1984 | Accident in chemical plant – methyl isocyanates released | India |
| 6 000 | – | 01.06.1976 | Heat wave, drought | France |
| 5 749 | 49 | 27.05.2006 | Earthquake (Mw 6.4); Bantul almost completely destroyed | Indonesia |
| 5 748 | 526 | 14.06.2013 | Floods caused by heavy monsoon rains | India |
| 5 422 | – | 25.06.1976 | Earthquake (Mw 7.1) | Indonesia |
| 5 374 | – | 10.04.1972 | Earthquake (Mw 6.6) in Fars | Iran |
| 5 300 | – | 28.12.1974 | Earthquake (Mw 6.0) | Pakistan |

Note: Mw = moment magnitude scale.
Source: Swiss Re Institute and Cat Perils.

[38] Dead and missing.
[39] Property and business interruption, excluding liability and life insurance losses.

# Terms and selection criteria

A natural catastrophe is caused by natural forces.

## Natural catastrophes

The term "natural catastrophe" refers to an event caused by natural forces. Such an event generally results in a large number of individual losses involving many insurance policies. The scale of the losses resulting from a catastrophe depends not only on the severity of the natural forces concerned, but also on man-made factors, such as building design or the efficiency of disaster control in the afflicted region. In this *sigma* study, natural catastrophes are subdivided into the following categories: floods, storms, earthquakes, droughts/forest fires/heat waves, cold waves/frost, hail, tsunamis, and other natural catastrophes.

A man-made or technical disaster is triggered by human activities.

## Man-made disasters

This study categorises major events associated with human activities as "man-made" or "technical" disasters. Generally, a large object in a very limited space is affected, which is covered by a small number of insurance policies. War, civil war, and war-like events are excluded. *sigma* subdivides man-made disasters into the following categories: major fires and explosions, aviation and space disasters, shipping disasters, rail disasters, mining accidents, collapse of buildings/bridges, and miscellaneous (including terrorism). In Tables 8 and 9 (pages 30–47), all major natural catastrophes and man-made disasters and the associated losses are listed chronologically.

Losses due to property damage and business interruption that are directly attributable to major events are included in this study.

## Economic losses

For the purposes of the present *sigma* study, economic losses are all the financial losses directly attributable to a major event, ie damage to buildings, infrastructure, vehicles etc. The term also includes losses due to business interruption as a direct consequence of the property damage. Insured losses are gross of any reinsurance, be it provided by commercial or government schemes. A figure identified as "total damage" or "economic loss" includes all damage, insured and uninsured. Total loss figures do not include indirect financial losses – ie loss of earnings by suppliers due to disabled businesses, estimated shortfalls in GDP and non-economic losses, such as loss of reputation or impaired quality of life.

The amount of the economic losses is a general indication only.

Generally, total (or economic) losses are estimated and communicated in very different ways. As a result, they are not directly comparable and should be seen only as an indication of the general order of magnitude.

The term "losses" refer to insured losses, but do not include liability.

## Insured losses

"Losses" refer to all insured losses except liability. Leaving aside liability losses, on one hand, allows a relatively swift assessment of the insurance year; on the other hand, however, it tends to understate the cost of man-made disasters. Life insurance losses are also not included.

NFIP flood damage in the US is included.

### *NFIP flood damage in the US*

The *sigma* catastrophe database also includes flood damage covered by the National Flood Insurance Program (NFIP) in the US, provided that it fulfils the *sigma* selection criteria.

*sigma* has been publishing tables listing major losses since 1970. Thresholds with respect to casualties – the number of dead, missing, severely injured, and homeless – also make it possible to tabulate events in regions where the insurance penetration is below average.

Thresholds for insured losses and casualties in 2017

For the 2017 reporting year, the lower loss thresholds were set as follows:

| Insured losses (claims): | | |
|---|---|---|
| | Maritime disasters | USD 20.3 million |
| | Aviation | USD 40.7 million |
| | Other losses | USD 50.5 million |
| *or* Total economic losses: | | USD 101 million |
| *or* Casualties | | |
| | Dead or missing | 20 |
| | Injured | 50 |
| | Homeless | 2000 |

## Adjustment for inflation, changes to published data, information

Losses are determined using year-end exchange rates and are then adjusted for inflation.

*sigma* converts all losses for the occurrence year not given in USD into USD using the end-of-year exchange rate. To adjust for inflation, these USD values are extrapolated using the US consumer price index to give current (2017) values.

This can be illustrated by examining the insured property losses arising from the floods which occurred in the UK between 29 October and 10 November 2000:

**Insured loss at 2000 prices: USD 1046.5 million**

**Insured loss at 2017 prices: USD 1489.9 million**

Alternatively, were one to adjust the losses in the original currency (GBP) for inflation and then convert them to USD using the current exchange rate, one would end up with an insured loss at 2017 prices of USD 1 344.7 million, 10% less than with the standard *sigma* method. The reason for the difference is that the value of the GBP declined by almost 10% against the USD in the period 2000-2017. The difference in inflation between the US (42.4%) and the UK (42.2%) over the same period was negligible.

**Figure 11**
Alternative methods of adjusting for inflation, by comparison

| Floods UK | | Exchange rate | | US inflation |
|---|---|---|---|---|
| 29 October–10 November 2000 | GBPmn | USD/GBP | USDmn | USDmn |
| Original loss | 700.0 | 1.495 | 1046.5 | 1046.5 |
| | | | | |
| Level of consumer price index 2000 | 72.7 | | | 100.0 |
| Level of consumer price index 2017 | 103.4 | | | 142.4 |
| Inflation factor | 1.422 | | | 1.424 |
| | | | | |
| Adjusted for inflation to 2017 | 995.4 | 1.351 | 1344.7 | 1489.9 |
| Comparison | | | 90% | 100% |

Source: Swiss Re Institute

Changes to loss amounts of previously published events are updated in the *sigma* database.

If changes to the loss amounts of previously published events become known, *sigma* takes these into account in its database. However, these changes only become evident when an event appears in the table of the 40 most costly insured losses or the 40 disasters with the most fatalities since 1970 (See Tables 10 and 11 on pages 48–49).

Only public information used for man-made disasters

In the chronological lists of all man-made disasters, the insured losses are not shown for data protection reasons. However, the total of these insured losses is included in the list of major losses in 2017 according to loss category. *sigma* does not provide further information on individual insured losses or about updates made to published data.

## Sources

Newspapers, direct insurance and reinsurance periodicals, specialist publications and other reports are used to compile this study.

Information is collected from newspapers, direct insurance and reinsurance periodicals, specialist publications (in printed or electronic form) and reports from insurers and reinsurers.[40] In no event shall Swiss Re be liable for any loss or damage arising in connection with the use of this information (see the copyright information on back inside cover).

Exchange rate used,[41] national currency per USD

| Country | Currecncy | Exchange rate, end 2017 |
|---|---|---|
| United Arab Emirates | AED | 3.6724 |
| Australia | AUD | 1.2786 |
| Canada | CAD | 1.2530 |
| Switzerland | CHF | 0.9744 |
| China | CNY | 6.5062 |
| Czech Republic | CZK | 21.2766 |
| Dominican Republic | DOP | 48.5437 |
| Eurozone | EUR | 0.8327 |
| United Kingdom | GBP | 0.7392 |
| Hong Kong | HKD | 7.8186 |
| Croatia | HRK | 6.1996 |
| India | INR | 63.6943 |
| Iran | IRR | 36075.0361 |
| Japan | JPY | 112.3596 |
| Sri Lanka | LKR | 153.8462 |
| Norway | NOK | 8.1766 |
| Nepal | NPR | 102.0408 |
| New Zealand | NZD | 1.4059 |
| Philippines | PHP | 50.0000 |
| Sierra Leone | SLL | 7672.2418 |
| Thailand | THB | 32.5733 |
| Turkey | TRY | 3.7936 |
| US | USD | 1.0000 |
| Vietnam | VND | 22706.6303 |
| South Africa | ZAR | 12.3762 |

Source: Swiss Re Institute

[40] Natural catastrophes in the US: those sigma figures which are based on estimates of Property Claim Services (PCS), a unit of the Insurance Services Office, Inc (ISO), are given for each individual event in ranges defined by PCS. The estimates are the property of ISO and may not be printed or used for any purpose, including use as a component in any financial instruments, without the express consent of ISO.
[41] The losses for 2017 were converted to USD using these exchange rates. No losses in any other currencies were reported

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| | | |
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