Weather, Climate & Catastrophe Insight

2020 Annual Report

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Executive Summary

2020: When Natural Disasters and a Pandemic Collide

Economic Loss

USD268 billion

10% above 21st Century average

Insured Loss

USD97 billion

40% above 21st Century Average

416

notable natural disaster events

53

billion-dollar economic loss events (second highest on record)

28

billion-dollar insured loss events (highest on record)

76%

of **global insured losses** were recorded in the United States

64%

global protection gap

1,922

fatalities during the India monsoon season; deadliest disaster of 2020

$35B

Cost of China's monsoon season in the worst Yangtze River Basin floods since 1998

M5.3

Magnitude of the destructive earthquake in Croatia on March 22

195 mph

(315 kph)

Wind speed of Typhoon Goni at landfall in the Philippines; strongest landfalling storm ever recorded globally

140 mph

(220 kph)

Estimated wind gusts during the August 10 Midwest derecho in Cedar Rapids, Iowa

30%

Portion of South America's Pantanal Region that burned due to wildfires in 2020

38.0°C / 100.4°F

Hottest temperature ever recorded above the Arctic Circle; June 20 at Verkhoyansk, Russia

+0.98°C (+1.76°F)

Above the 20th Century Average Per NOAA: World's second-warmest year on record for land and ocean temperatures dating to 1880

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

Opening Remarks

2020 proved to be one of the most challenging years in modern history. Following an above-average number of natural catastrophes with significant humanitarian and financial impacts, coupled with the most prolific global pandemic since 1918, the world heads into 2021 with numerous questions to be answered.

While 2020 was not a record-setter in terms of financial losses deriving from natural disasters, there were several notable records set on a regional, peril or event-level scale. The most widespread and newsworthy events in 2020 were recorded in the United States. During **a record-setting Atlantic Hurricane Season** with 30 named storms, 13 hurricanes, and 6 major hurricanes, the U.S. mainland saw 12 of those named storms (including six hurricanes) make landfall. Both of those U.S. landfall statistics set new records for the country dating to the mid-1800s. While hurricanes dominated most headlines, the **costliest U.S. peril was severe convective storm** (SCS). The peril surpassed 2011 as the costliest severe weather season on record, previously considered the benchmark year for SCS, and was led by the historic derecho that swept across the Midwest on August 10. Wildfires in the Western U.S. also prompted a new modern era record for acres burned and the third-highest annual peril payouts for insurers on record (only behind 2017 and 2018).

While re/insurers faced a challenging year in the United States, it was a different story for the rest of the world. **Aggregate payouts outside the U.S. were diminished.** However, the fiscal analysis is only a small part of the broader story. Prolific rainfall in parts of south Asia left some of the worst monsoon season flooding in years (notably in China, Japan, India, and South Korea). Multiple hailstorms struck major metro areas in Australia. Drought conditions ravaged parts of South America. Europe endured its costliest winter windstorm in nearly a decade. Several African nations cited high casualties following major flooding. These events occurred within the broader realm of COVID-19, and resulted in major challenges from a relief and recovery standpoint.

COVID-19's coinciding impact to natural disaster response from a humanitarian perspective was enormous. World organizations such as the United Nations (UN) pleaded for financial support and volunteers to help people in need. The insurance industry was faced with enormous challenges in trying to accelerate the claims process while balancing multiple large-scale disasters, pending litigation from COVID-19-related incidents, increased replacement costs due to a disrupted supply chain, and other complex scenarios. However, the re/insurance industry managed to weather the storm successfully as continued strong capitalization allowed all disasters to be comfortably managed where cover was in place.

Perhaps the biggest takeaway from 2020 was the recognition of how concurrent events can have major global implications. These "compounded" or **"connected extremes" will provide critical learning opportunities for better planning** as the world becomes increasingly complex and faces growing or emerging risks. 2020 also highlighted topics such as the protection gap to address the underserved, increasingly vulnerable populations, the need for additional investment around risk mitigation strategies to navigate new forms of volatility, and the growing influence from climate change on daily life.

This report is designed to help in the following ways:

1

Identify trends

- Explore global and regional catastrophe loss drivers
- Data-driven analysis highlighting vulnerable locales
- Recognize climate change influence on individual events

2

Enhance risk mitigation

- Develop public and private risk mitigation, disaster response and business continuity solutions – notably in the most vulnerable regions of the world
- Focus on the importance of modernizing and implementing stringent building code requirements
- Improve the communication of risk and uncertainty

3

Transfer risk

- Develop insurance and investment strategies to protect people and assets
- Introduce affordable and relevant products to help close the global protection gap

4

Build resilience

- Increase public-private collaborations across government, academia, charities and the private sector to mitigate risk and create more resilient communities

Along with this report, we welcome readers to access current and historical natural catastrophe data and event analysis at **catastropheinsight.aon.com**

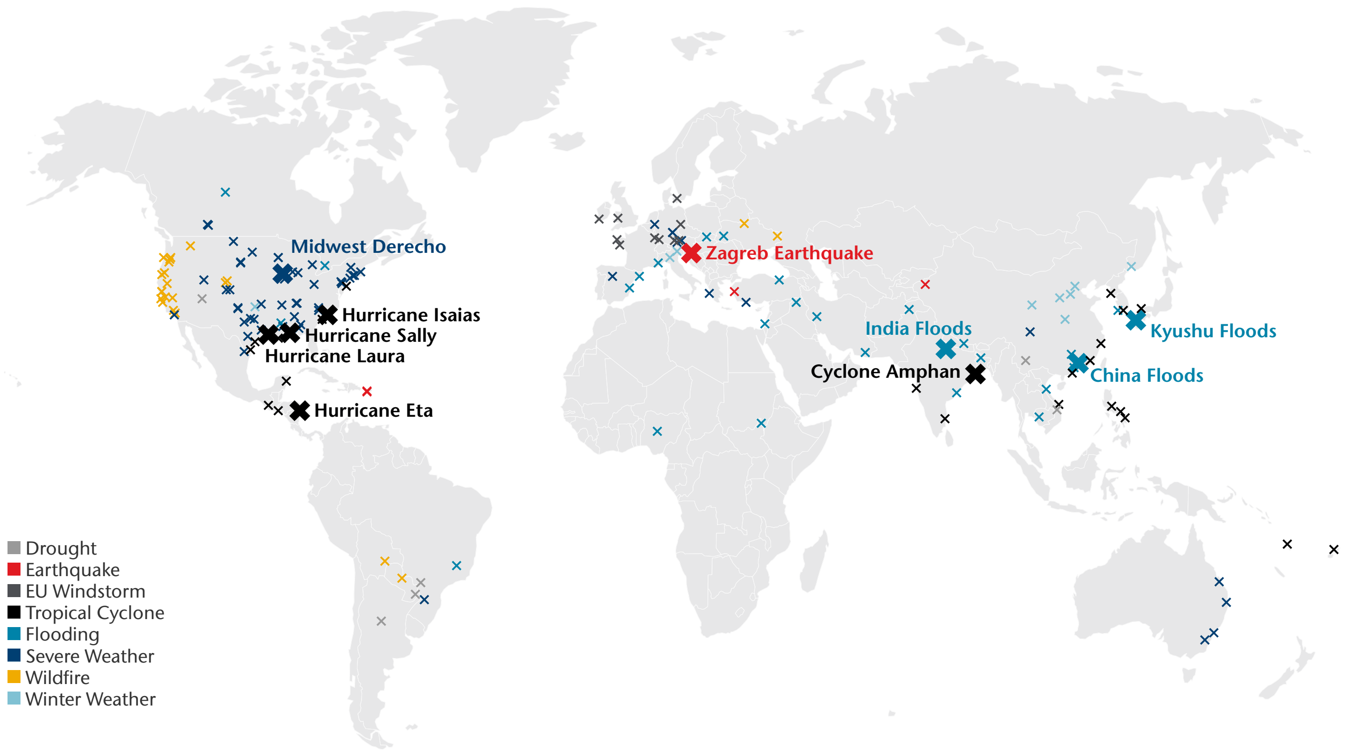
2020 Natural Disaster Events & Loss Trends

Global Economic Losses

Exhibit 1: Top 10 Global Economic Loss Events[1,2]

Date(s)	Event	Location	Deaths	Economic Loss (USD billion)	Insured Loss (USD billion)
June-September	Seasonal Floods	China	280	35.0	2.0
August 21-29	Hurricane Laura	U.S., Caribbean	68	18.2	10.0
May 15-21	Cyclone Amphan	South Asia	133	15.0	0.5
August 8-12	SCS (incl. Midwest Derecho)	United States	4	12.6	8.3
July 3-15	Kyushu Floods	Japan	82	8.5	2.0
November 2-13	Hurricane Eta	Caribbean, U.S.	309	8.3	0.7
June-September	Seasonal Floods	India	1,922	7.5	0.8
September 14-18	Hurricane Sally	United States	0	7.0	3.5
March 22	Zagreb Earthquake	Croatia	2	6.1	0.1
July 30-August 5	Hurricane Isaias	U.S., Caribbean, Canada	18	5.0	2.7
			All other events	145 billion	66 billion
			Totals	**268 billion**	**97 billion**

Exhibit 2: Significant 2020 Economic Loss Events[3]



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[1] Subject to change as loss estimates are further developed

[2] Includes losses sustained by private insurers and government-sponsored programs

[3] Based on events that incurred economic loss greater than USD100 million. Position of an event is determined by the most affected administrative unit or epicenter

Data: Aon (Catastrophe Insight)

Direct economic losses and damage from natural disasters in 2020 were estimated at USD268 billion. While much lower than peak loss years in 2011 (USD557 billion) and 2017 (USD485 billion), it was above the average (USD244 billion) and median (USD246 billion) of the 21st Century. The economic losses were 12 percent lower than the average and one percent lower than the median of the past decade (2010-2019). Note that the median being lower than the average is indicative of a "skew to the left", and that low loss years early in the 21st Century helped bring down the average.

In terms of economic losses resulting solely from weather disasters – which are defined as events caused by atmospheric-driven scenarios – the global total was USD258 billion, which was 29 percent higher than the 21st Century average and 37 percent above the median. 2020 was the fifth costliest year on record in terms of weather-related natural disasters after adjusting for inflation. Weather-only loss analysis allows an ability to see any possible climate change trends emerging.

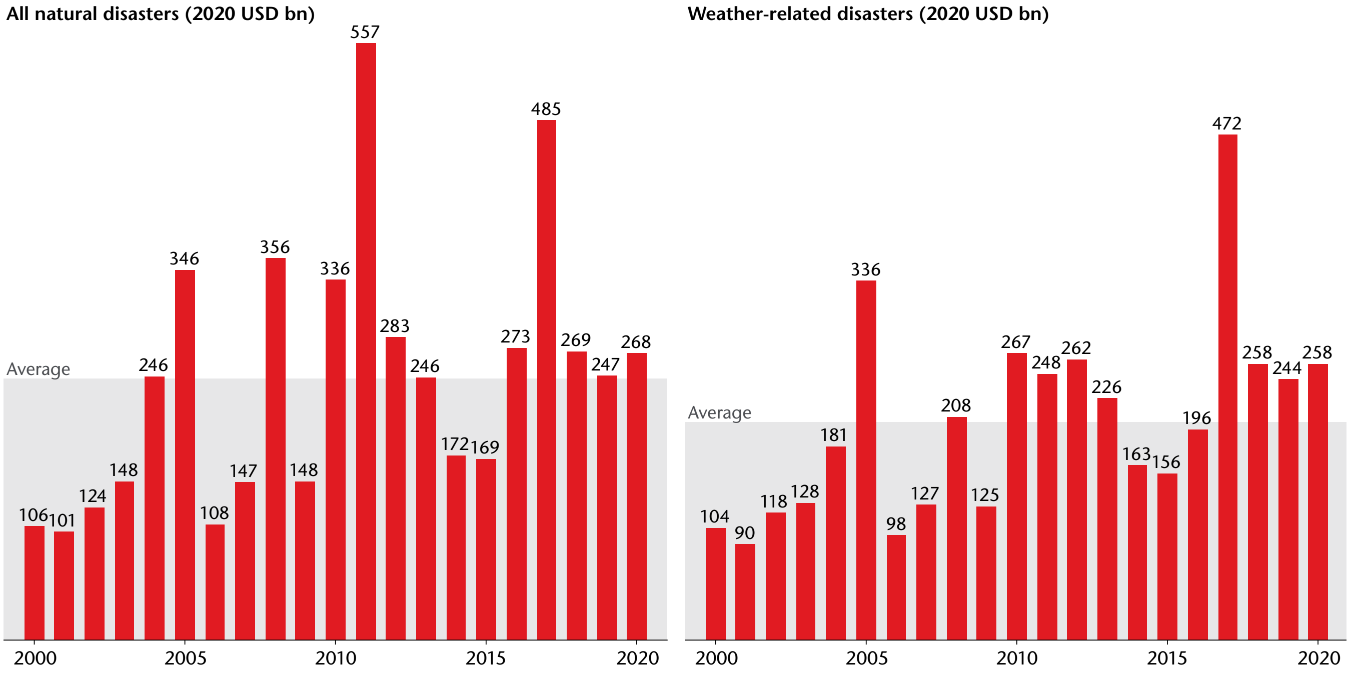
The costliest individual peril was **tropical cyclone** at nearly USD78 billion. The most active Atlantic hurricane season on record generated economic losses of USD50 billion. Although a significant total, it only represents a fraction – 16 percent – of the record year of 2017. The costliest storm outside of the North Atlantic basin was the destructive Cyclone Amphan that heavily affected parts of India and Bangladesh. Notably, Philippines endured two disastrous landfalls in 2020, including Goni, which was the strongest landfall ever recorded on the planet.

The tropical cyclone peril was closely followed by inland **flooding** (USD76 billion). Global flood losses were largely driven by events in Asia; China, India and Japan alone accounted for more than USD50 billion of the toll.

Perhaps most noteworthy was the **severe convective storm** (SCS) peril. 2020 marked the costliest year on record for SCS with USD63 billion in economic losses, surpassing the previous record of 2011 (USD53 billion). This is aligned with the overall increasing trend for the peril throughout the 21st Century. It is worth noting that more than 80 percent of the loss was incurred in the United States alone, which was amplified by a major derecho event in August.

Another anomalous year for **wildfires** resulted in total economic losses topping USD19 billion. There were five individual billion-dollar fires in the Western United States alone; a new national record.

Exhibit 3: Global Economic Losses



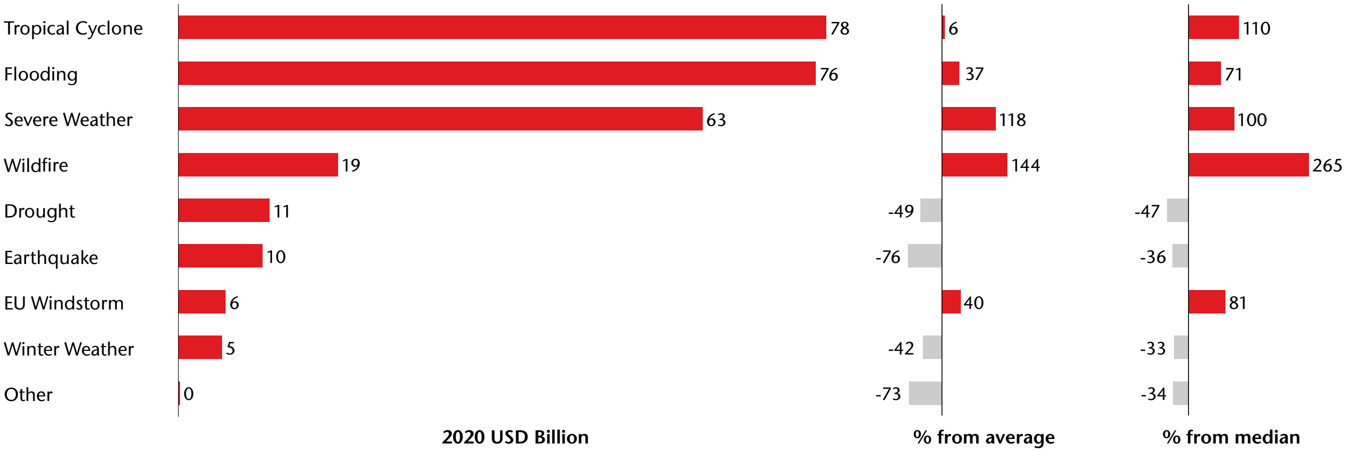
All natural disasters (2020 USD bn)

Weather-related disasters (2020 USD bn)

Data: Aon (Catastrophe Insight)

At USD78 billion, the tropical cyclone peril was the costliest of 2020 on an economic basis. Other perils with above-median losses included flooding, severe weather, wildfire and European windstorm. All other perils were notably below long-term mean and median values (since 2000).

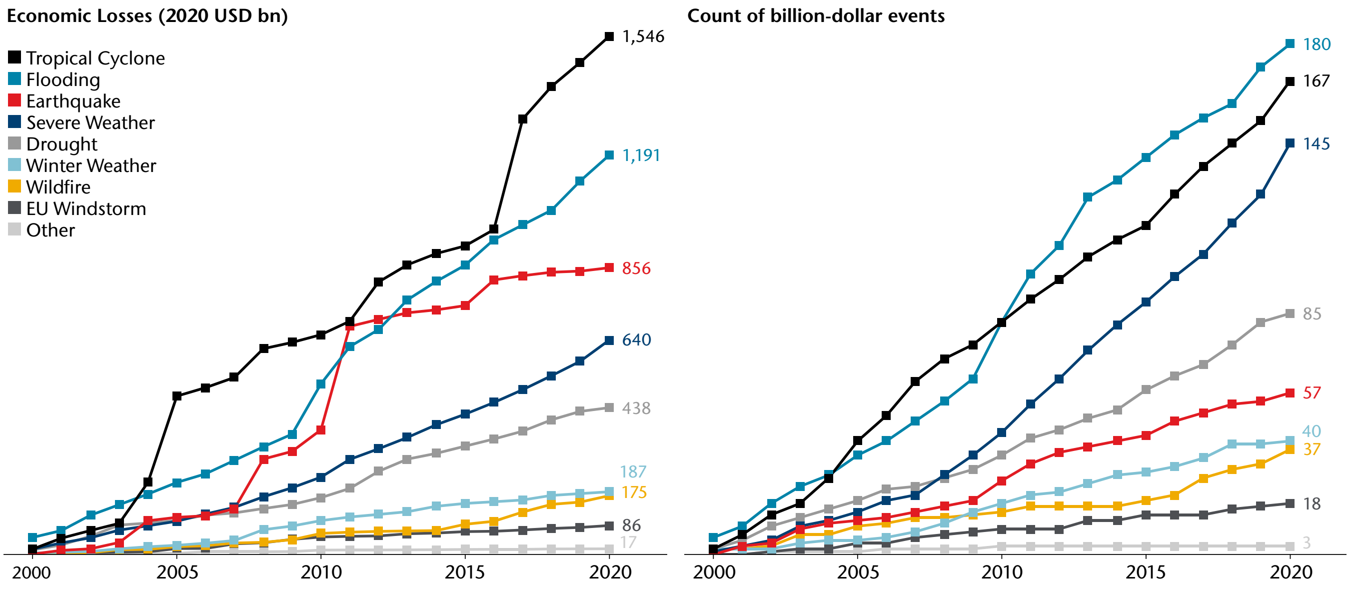
Exhibit 4: 2020 Global Economic Losses by Peril



Data: Aon (Catastrophe Insight)

The costliest peril since 2000 from a global perspective has been tropical cyclone. Like earthquake, it was largely driven by extreme loss years and single catastrophic events, as opposed to severe weather peril, which shows a strong and consistent increasing trend in annual economic losses. SCS also accounted for the highest number of billion-dollar events in 2020.

Exhibit 5: Cumulative Economic Losses by Peril

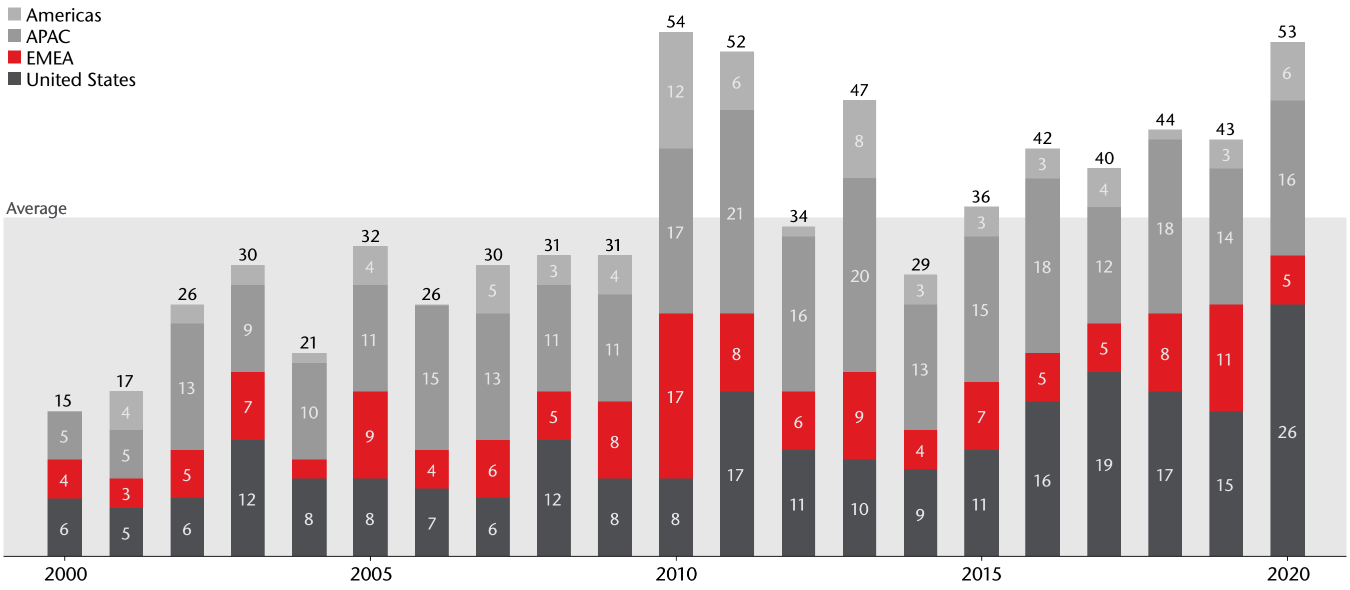

Economic Losses (2020 USD bn)

Count of billion-dollar events

Data: Aon (Catastrophe Insight)

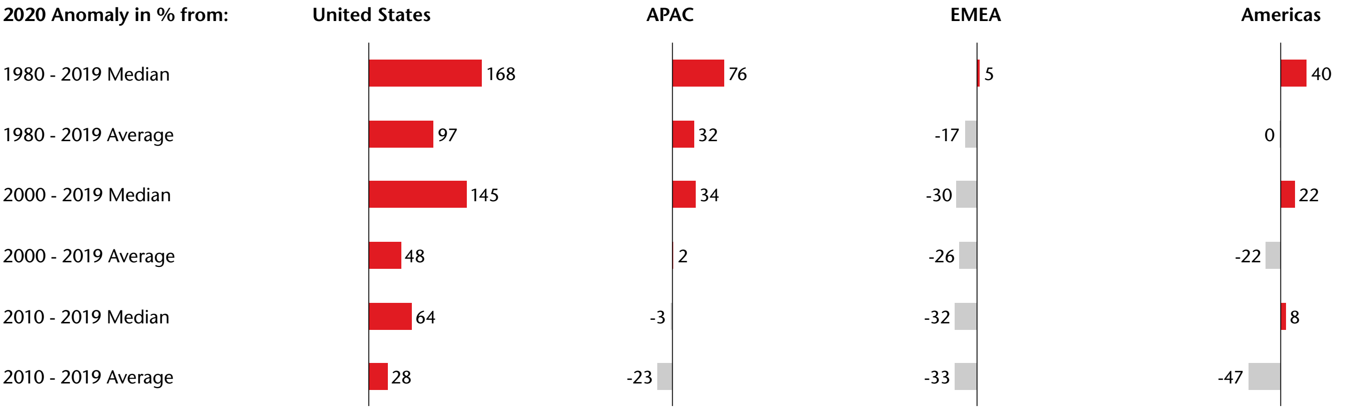
There were 53 individual billion-dollar natural disaster events in 2020, which was well above the average of 34 events dating to 2000 and higher than the total of 43 recorded in 2019. *Please note that U.S. Wildfires are treated as individual events; there were five such events in 2020. Hurricane Eta was a billion-dollar event in both the Americas and United States, but is only displayed once, as an Americas event since a higher cost was incurred there. The U.S. had a total of 27 billion-dollar events.*

Exhibit 6: Global Billion-Dollar Economic Loss Events



Note: Exhibit 6 includes events which reached the billion-dollar-plus (USD) threshold after an inflation-adjustment based on the 2020 U.S. Consumer Price Index.
Data: Aon (Catastrophe Insight)

Exhibit 7: 2020 Economic Loss Deviation from Historical Benchmarks



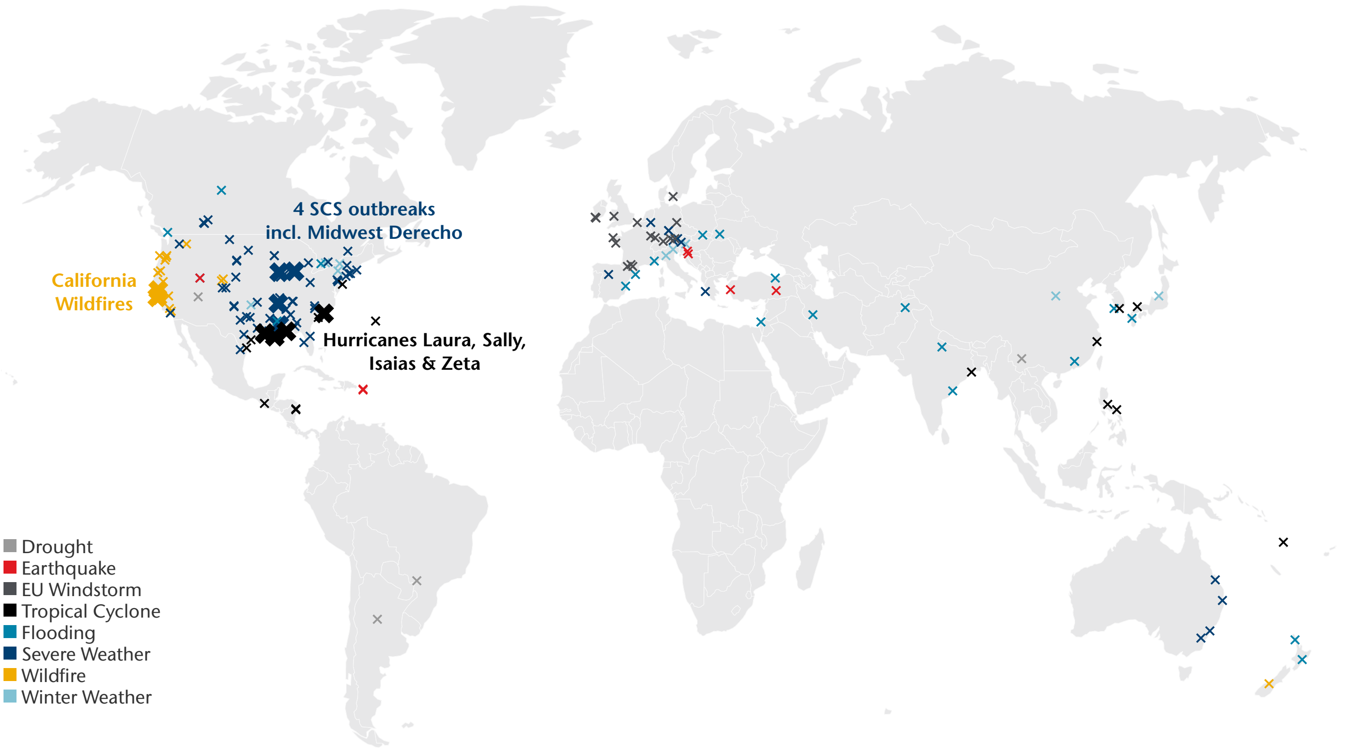
Data: Aon (Catastrophe Insight)

Global Insured Losses

Exhibit 8: Top 10 Global Insured Loss Events[1,2]

Date(s)	Event	Location	Deaths	Economic Loss (USD billion)	Insured Loss (USD billion)
August 21-29	Hurricane Laura	U.S., Caribbean	68	18.2	10.0
August 8-12	SCS (incl. Midwest Derecho)	United States	4	12.6	8.3
September 14-18	Hurricane Sally	United States	0	7.0	3.5
September 27-October 5	Glass Fire	United States	4	4.0	2.9
July 30-August 5	Hurricane Isaias	U.S., Caribbean, Canada	18	5.0	2.7
April 10-14	Easter Tornado Outbreak	United States	38	3.6	2.7
August 17-September 22	CZU Lightning Complex Fire	United States	1	3.5	2.4
April 6-9	Severe Weather	United States	0	3.0	2.3
October 24-30	Hurricane Zeta	U.S., Caribbean	8	3.6	2.3
March 27-30	Severe Weather	United States	0	2.9	2.2
			All other events	205 billion	58 billion
			Totals	**268 billion**	**97 billion**

Exhibit 9: Significant 2020 Insured Loss Events[3]



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[1] Subject to change as loss estimates are further developed

[2] Includes losses sustained by private insurers and government-sponsored programs

[3] Based on events that incurred insured loss greater than USD25 million. Position of an event is determined by the most affected administrative unit or epicenter.

Data: Aon (Catastrophe Insight)

Insured losses derived from natural disasters in 2020 reached USD97 billion and were well above the 21st Century mean (USD69 billion) and median (USD61 billion) values. It marked the fifth costliest year for public and private insurance entities on record; only behind 2017, 2011, 2005, and 2018. It also represented a 26 percent increase from 2019.

Weather-related disasters accounted for nearly all insured natural disaster losses (99 percent). This was due to a relatively low number of significant earthquake events, and the fact that where the events did occur, they were located predominantly in regions with lower insurance take-up.

Roughly 36 percent of global economic losses were covered by insurance, which translates to a protection gap of 64 percent, fourth lowest on record after 2005, 2018 and 1992.

Global insured losses were dominated by events that occurred in the United States, which accounted for 76 percent of the total. For comparison, the U.S. share of global insured losses has averaged at 57 percent during the 21st Century. On the other extreme, European insurers saw the lowest losses since 2006, mainly due to a lack of significant severe convective storm events. It also occurred despite above-average calendar year windstorm losses.

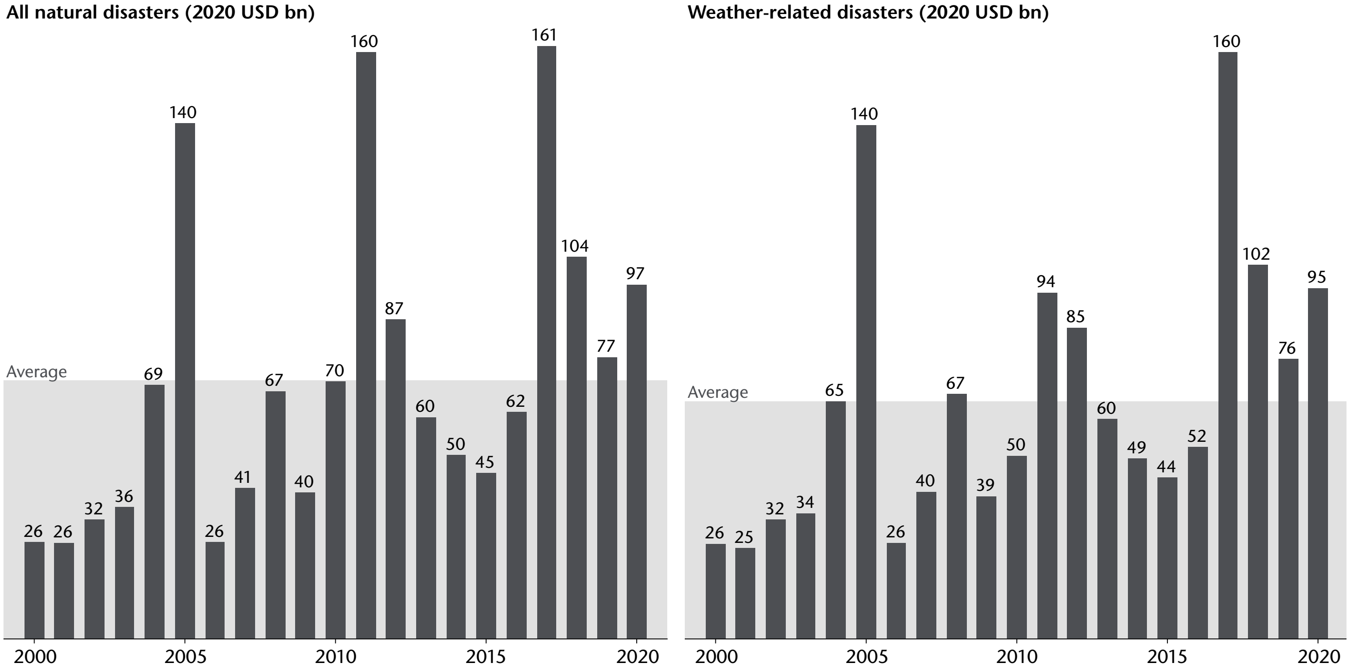
The Top 10 insured loss events each occurred in the United States. These disasters accounted for more than 40 percent of global insured losses. Despite a record-breaking hurricane season, only Laura generated losses of USD10 billion. There were three other multi-billion-dollar tropical cyclone events: Sally, Isaias and Zeta. The list also included four severe convective storm events, including the August 8-12 U.S. severe weather outbreak that included the historic Midwest Derecho on August 10. The derecho was regarded as the single costliest thunderstorm cluster event ever recorded. Separately, U.S. insurers saw another anomalous year for wildfires with four individual billion-dollar events (3 in California and 1 in Oregon).

The costliest event outside of the U.S. was Windstorm Ciara (Sabine), which impacted Western, Central and Northern Europe in February and generated more than 1 million insurance claims. The other multi-billion-dollar global insured events included seasonal floods in China and flooding in Japan's Kyushu.

Severe convective storm peril was the main driver of the insured losses globally, being responsible for more than 43 percent of the worldwide total. The peril also added 14 individual billion-dollar events, the highest number on record for any peril, of which 12 occurred in the United States.

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

Exhibit 10: Global Insured Losses



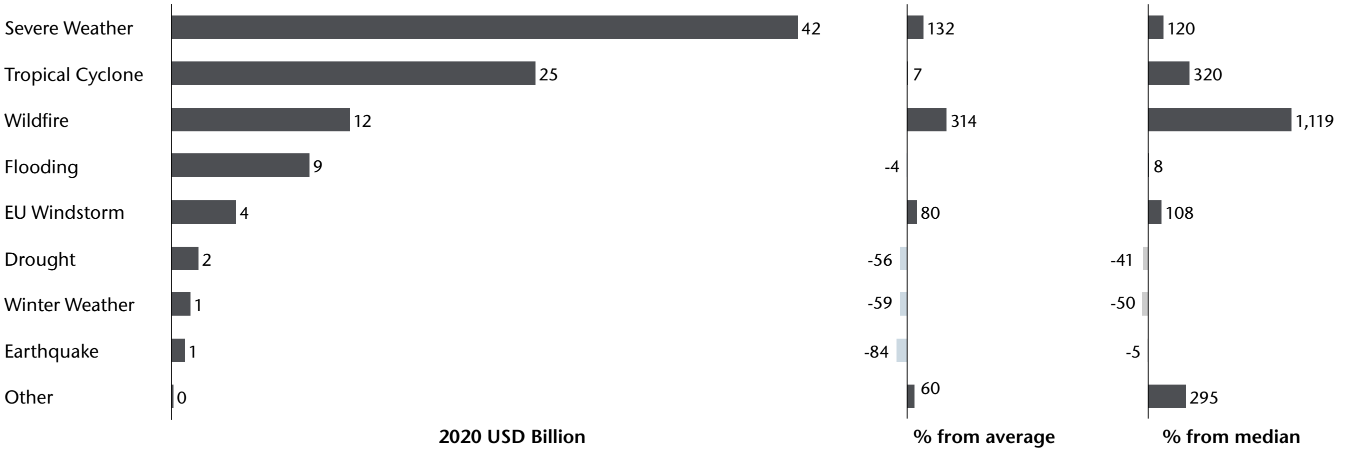
All natural disasters (2020 USD bn)

Weather-related disasters (2020 USD bn)

Data: Aon (Catastrophe Insight)

Insured losses in 2020 were dominated by the severe convective storm peril, with a global total of USD42 billion. It was followed by tropical cyclone and wildfire, whose losses were also largely driven by events in the United States. Notably, payouts related to European windstorms were above average and median of the 21st Century.

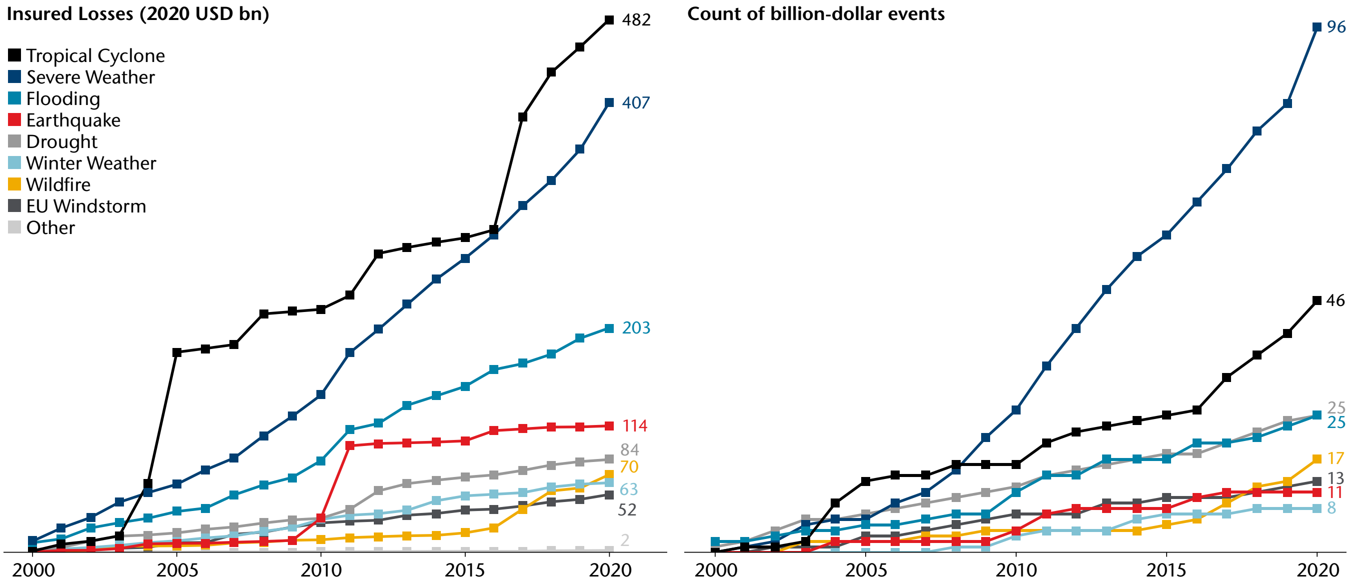
Exhibit 11: 2020 Global Insured Losses by Peril



Data: Aon (Catastrophe Insight)

The tropical cyclone peril remained the costliest in the 21st Century, although the severe weather peril far outpaced it and added 14 individual billion-dollar events in 2020. The peril now holds a dominant position this century in terms of number of billion-dollar events. The 96 events compare with 145 for all the other perils combined. Remarkably, wildfire has been responsible for more than USD70 billion insured losses since 2000, of which 75 percent was incurred in the last five years alone.

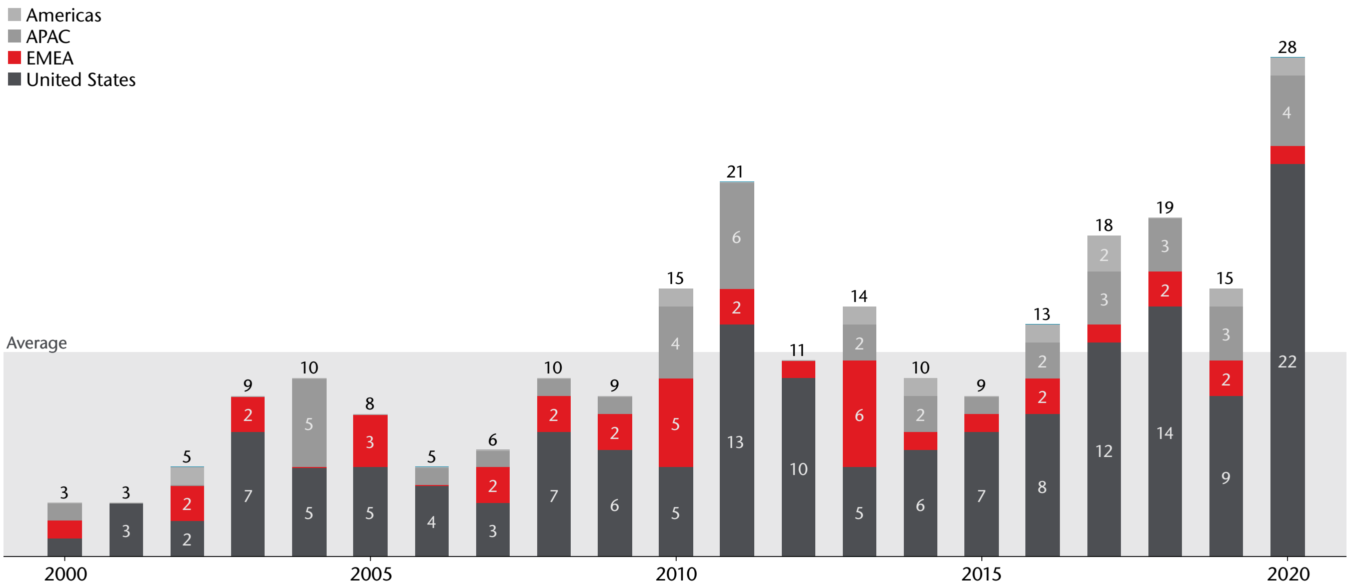
Exhibit 12: Cumulative Insured Losses by Peril



Data: Aon (Catastrophe Insight)

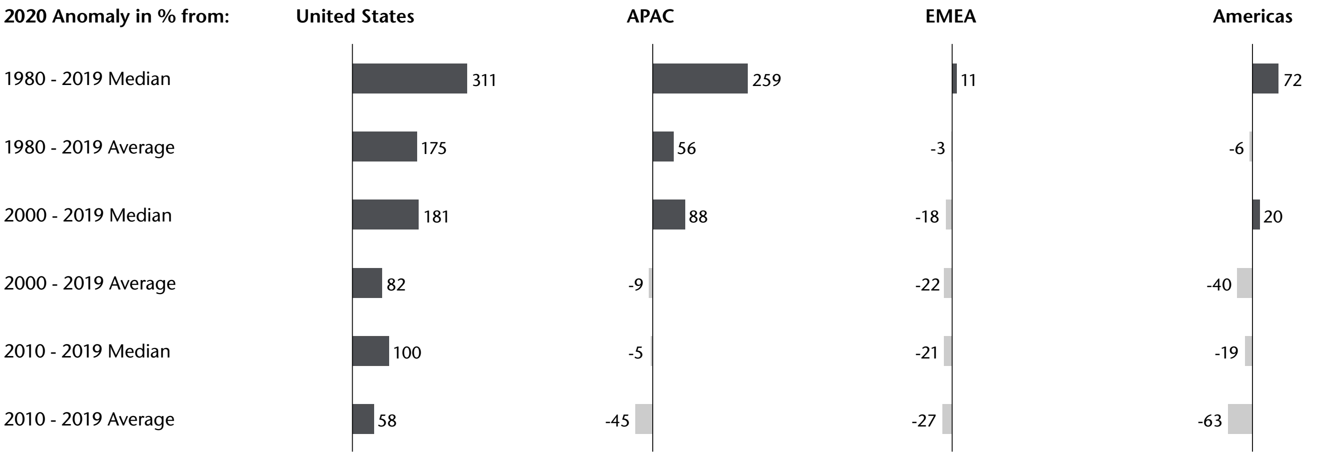
There were 28 individual billion-dollar natural disaster events in 2020 in terms of insured loss, the highest total ever recorded. Twenty-two (22) occurred in the United States. The rest included Windstorm Ciara in Europe, seasonal flooding in China and Japan, hailstorms in Calgary, Canada in June, and further hailstorms in multiple Australian cities in January. These record numbers were driven by 14 severe convective storm events, of which 12 occurred in the United States alone. *Please note that U.S. Wildfires are treated separately; there were four such events in 2020.*

Exhibit 13: Global Billion-Dollar Insured Loss Events



Note: Exhibit 13 includes events which reached the billion-dollar-plus (USD) threshold after being adjusted for inflation based on the 2019 U.S. Consumer Price Index.
Data: Aon (Catastrophe Insight)

Exhibit 14: 2020 Insured Loss Deviation from Historical Benchmarks



Data: Aon (Catastrophe Insight)

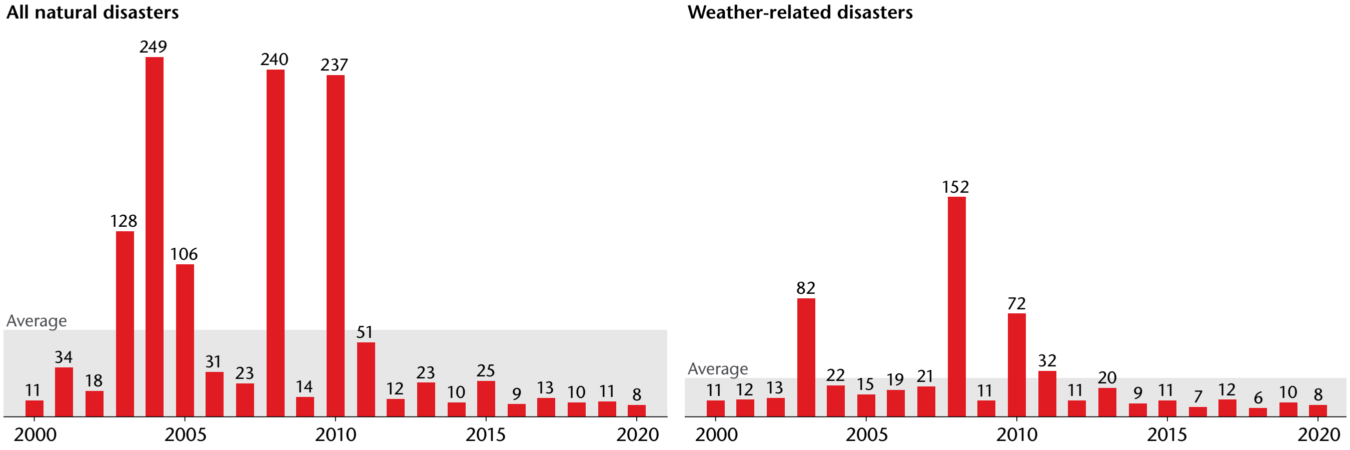
Global Fatalities

Exhibit 15: Top 10 Human Fatality Events

Date(s)	Event	Location	Deaths	Economic Loss (USD billion)
June-September	Seasonal Floods	India	1,922	7.5
June-September	Seasonal Floods	Pakistan	410	1.5
July-September	Seasonal Floods	Nepal	401	0.1
November 2-13	Hurricane Eta	Caribbean, U.S.	309	8.3
June-September	Seasonal Floods	China	280	35.0
June-September	Seasonal Floods	Bangladesh	260	0.5
April-June	Flooding	Kenya	237	< 0.1
August 24-27	Flooding	Afghanistan	190	< 0.1
August 2-7	Flooding	Yemen	174	< 0.1
January 11-14	Winter Weather	South Asia	157	< 0.1
		All other events	~3,700	215 billion
		Totals	**~8,100**	**268 billion**

Globally, approximately 8,100 people lost their lives due to natural catastrophe events in 2020, of which at least 3,500 occurred due to prolonged monsoon flooding in Asia alone. Sixty-eight (68) percent of deaths were reported from the Asia-Pacific (APAC) region while Europe, Middle East, Africa (EMEA) registered 22 percent of total lives lost to natural disasters. Prolonged Indian monsoon flooding between June through September was the deadliest event with at least 1,922 registered deaths. Elsewhere in South Asia – particularly in Pakistan, Nepal, and Bangladesh – another 1,100 people lost their lives to anomalous monsoon rains. A magnitude-7.0 earthquake in the Aegean Sea on October 30, which caused at least 117 combined casualties in Turkey and Greece, was the deadliest earthquake event of 2020. The deadliest tropical cyclone of 2020 was Hurricane Eta, which claimed lives of at least 309 people. *Please note that confirmed fatalities and missing people presumed dead are included in the above totals.*

Exhibit 16: Global Human Fatalities (thousands)



All natural disasters

Weather-related disasters

Data: Aon (Catastrophe Insight)

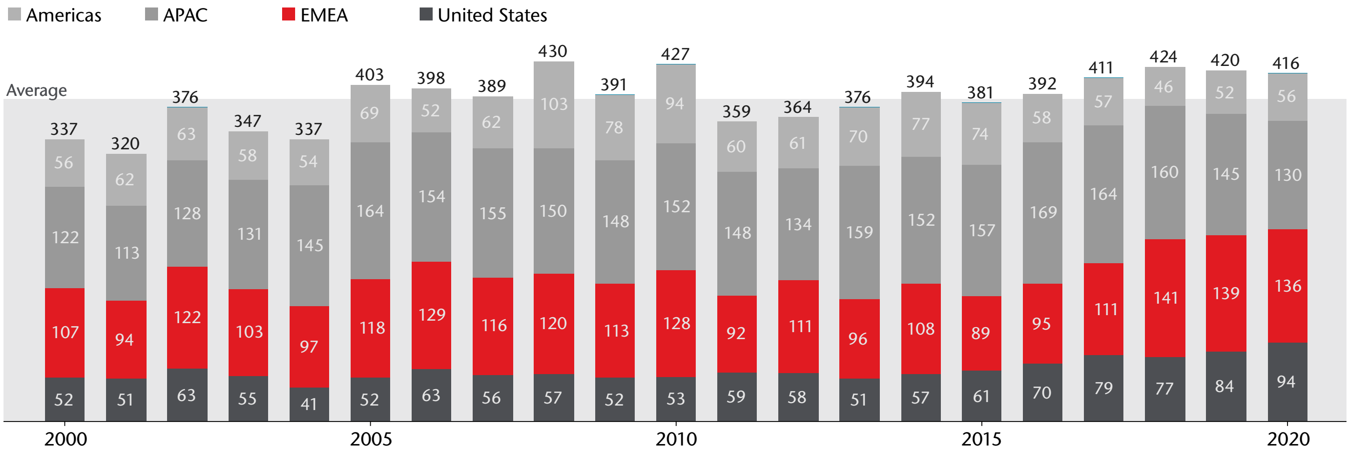
Natural Disasters Defined and Total Events

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

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

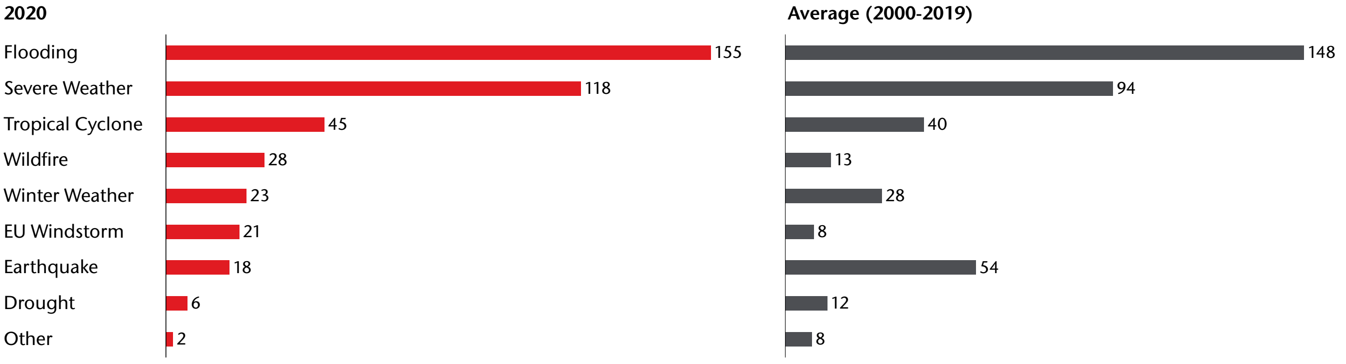
Based on the noted criteria above, there were at least 416 individual natural disaster events in 2020, which was above the average (384) and median (390) since 2000. As typically anticipated given the highest frequency of SCS, flood, and tropical cyclones, the highest number of disaster events occurred during the second (111) and third (124) quarters. The United States recorded 94 disaster events, as per this report's criteria, the highest national total on record.

Exhibit 17: Total Natural Disaster Events



Data: Aon (Catastrophe Insight)

Exhibit 18: Total Natural Disaster Events by Peril



Data: Aon (Catastrophe Insight)

COVID-19: Global Impacts Beyond the Virus

2020 was a year that posed a series of unique and consequential challenges to livelihoods around the world. The dominant topic surrounded COVID-19, which became the deadliest pandemic on Earth since the 1918 influenza pandemic. The World Health Organization (WHO) estimated that more than 10 percent of the world's population was likely to have been infected by the coronavirus. The substantive impact of the global economy led to considerable human and fiscal impacts that will be felt for years to come. The following will highlight how the direct and indirect impacts from COVID-19 were enhanced by an active year for natural disasters and how the virus became interlinked with other facets of daily life (including disaster response).

Safely Responding to Natural Disasters

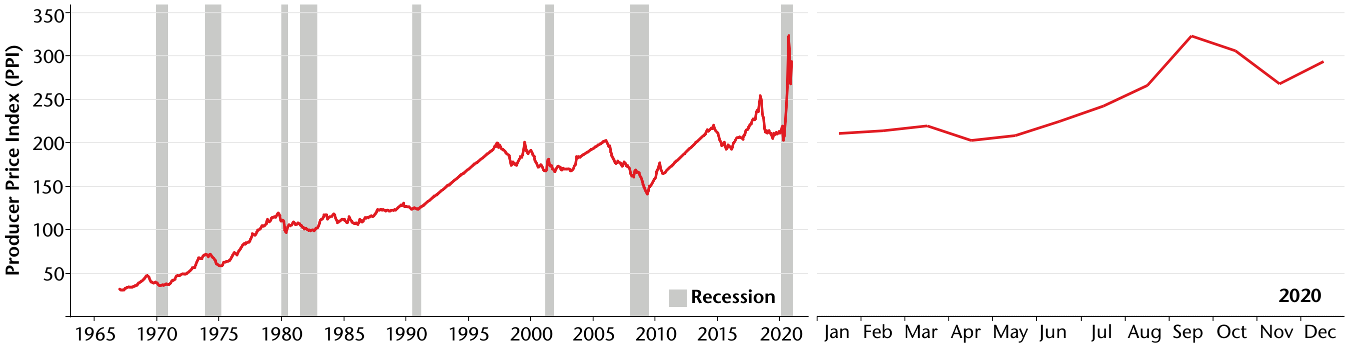
The prospect of a pending natural disaster and the post-event recovery/response is always a difficult endeavor for even the best prepared countries. The volume of natural disaster events in 2020, including several that had impacts across multiple states / countries, led to above-average disaster costs and forced federal governments to tap into already depleted emergency funding to account for the many billions of dollars (USD) in non-insured damage and recovery aid.

Perhaps the most challenging aspect for local and federal officials, even beyond the fiscal requirements, was the planning process around large-scale evacuations and post-event temporary housing procedures in the COVID-19 environment. Many countries enacted social distancing and strict screening guidelines that required new evacuation center set-ups that limited the number of evacuees per facility. The lack of facilities led to many people being sent by organizations to non-traditional displacement shelters for longer-term housing, most frequently a hotel. In other cases, regions facing tropical cyclones or inland flooding placed COVID-19 patients in "emergency hospitals" that were often identified in high-risk hazard areas. These unintended consequences put heightened strain on the need for quick and complex resilience planning. The other difficulty was locating enough volunteers to aid and/or be deployed in the hardest-hit areas to begin the relief and recovery process. Organizations such as the International Federation of Red Cross and Red Crescent noted some regional spikes in volunteer sign-ups, but many were asked to respond to disasters virtually and often to provide mental health support since "on the ground" physical recovery was not plausible. The frequency of larger-scale events, notably in the United States, Central America, and Asia, stretched resources thin.

Disrupted Insurance Claim Process

One of the more visible challenges around COVID-19 was the insurance industry response regarding the claims process. Varying restrictions around social distancing and public health safety limited the number of assessors that were deployed in the aftermath of events. This inevitably led to delays in some claims being processed and/or approved. Many re/insurers began to incorporate new technologies to aid the claims process. Among the most notable was the introduction of drones to conduct survey assessments from the air. Other companies relied on their clientele to take numerous pictures or videos of the damage to support the approval process.

Exhibit 19: Seasonally Adjusted U.S. Commodity Data – Lumber & Wood Products (1967-2020)



Data: U.S. Bureau of Labor Statistics Graphic: Aon

From a payout perspective, one of the additional challenges faced by re/insurers surrounded shortages of lumber and other construction material during the rebuilding process. The high frequency of natural disaster events in combination with global supply chain disruptions due to COVID-19, a reduction in factory productivity, changes in tariff structures, an increase in home construction and remodeling projects, beetle infestation in valuable forested areas, and recent major wildfires all contributed to a limited volume of construction material. This reduction in supply inevitably led to higher replacement costs, and subsequently, an increase in the payout by re/insurers. The replacement cost increase faced in 2020 is not dissimilar to what re/insurers faced in 2017 with the Assignment of Benefits (AOB) topic. AOB deals with a third-party being given authority to file a claim, make repair decisions, and collect insurance payments without the homeowner needing to be directly involved. This led to elevated loss payouts in Florida following the 2017 Atlantic Hurricane Season; notably for Hurricane Irma.

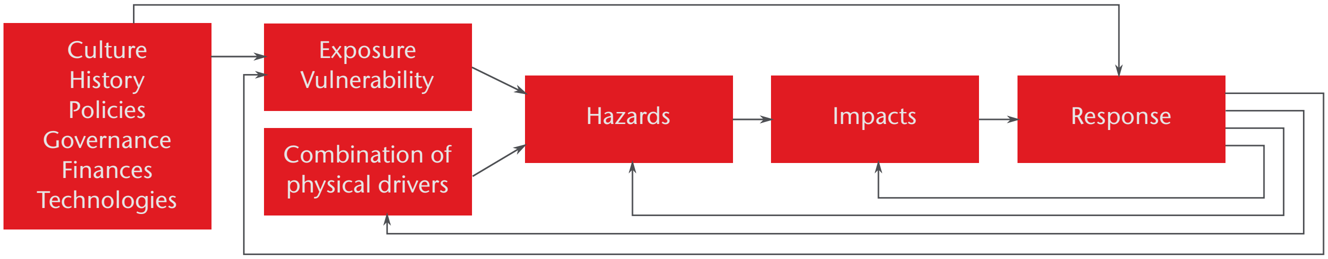
Compounded / Connected Extremes

When faced with a sequence of mid- or large-scale disasters occurring within short order, it is even more challenging for local and federal governments to properly plan and initiate multiple responses. These same difficulties apply for the private sector, including the re/insurance industry. What 2020 and COVID-19 presented was the latest example of more interconnected events – whether they are natural or man-made – having a major impact on a global scale. These coinciding and impactful incidents can more accurately be defined as "compounded" or "connected extremes".

Prior to 2020, this topic was already gaining more attention as public and private sector groups further recognized the direct tie between natural disasters, climate change, healthcare, insurance, food insecurity, infrastructure, and other various societal and geopolitical topics. Years such as 2011 and 2017 were particularly notable from the connected extremes viewpoint as major natural disaster events led to localized physical damage impacts, but created a cascading effect of secondary and tertiary global fiscal impacts far beyond where the events occurred. Using 2011 as an example, the double-whammy of the Tohoku (Japan) Earthquake / Tsunami and the Thailand Floods led to a significant impact to the global supply chain around many types of products. Despite feeling no direct physical impact, factories elsewhere across Asia, Europe, and North America were unable to manufacture their own products since key components from Japan and/or Thailand were never delivered. Such scenarios highlight potentially devastating feedback loops which can cripple economies and subsequently lead to prolonged human suffering.

The amplified effects realized in 2020 would have been challenging enough had it only been defined by the frequency of extreme weather events. These extreme events occurring in the COVID-19 environment only enhanced the humanitarian impact. Delays in the shipment of typically standard international aid (such as food, healthcare supplies, etc.) prolonged the initial recovery efforts that many developing or emerging countries are heavily reliant. It also increased the delivery cost of aid as supply shortages and enhanced safety precautions required more monetary requirements. As a result, the United Nations (UN) increased their humanitarian aid appeal for 2021 to USD35 billion – up from USD28 billion in 2020. It also anticipated 235 million people, or equal to 1 in 35 people worldwide, needing assistance from natural peril, geopolitical, or COVID-related incidents. Most help will be targeted in 56 of the most vulnerable nations on earth.

Exhibit 20: Diagram of Interactions Between Physical & Societal Drivers in Connected Extremes[1]



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[1] *Raymond, C., Horton, R.M., Zscheischler, J. et al. Understanding and managing connected extreme events. Nat. Clim. Chang. 10, 611–621 (2020).* https://doi.org/10.1038/s41558-020-0790-4

Future Planning

Perhaps the biggest opportunity in the aftermath of 2020 surrounds the topic of risk management. COVID-19 highlighted areas which need considerable improvement around both planning for and anticipating various scenarios. The identification of risk is a critical first step. One valuable solution which can help invoke a risk planning strategy is around risk mapping. These tools can not only highlight the hazard risk down to a granular level (perhaps downscaled to a zipcode or CRESTA level), but also identify areas that may require improved building code requirement or enforcement. However, this type of solution is likely more realistic for more developed nations. Countries that face more widespread wealth inequality – meaning a higher portion of the local population living in poverty or with limited financial means – will require different methods to aid in risk management. Meanwhile, there are also opportunities to rethink access to capital with solutions such as catastrophe bonds or parametric insurance. This trigger-based approach can quickly bring an influx of fiscal aid into areas which are not able to depend on federal dollars.

While natural hazards cannot be eliminated, the physical and human risk can certainly be minimized or mitigated against by properly reducing vulnerability. By combining the most effective resources from government, insurance, urban planning, academia, emergency management, real estate, investment banking, and other important non-governmental organizations (NGOs), this can create a strong framework that includes ideas from the most important stakeholders. As climate change exacerbates a host of scientific, societal, and geopolitical hazards, and global events such as COVID-19 occur in tandem, it has never been more critical than now to avoid the creation of new risks (such as failing to address growth of vulnerable exposure without proper planning or mitigation strategies in place), address current risks, and start preparing for event scenarios previously assumed to be unrealistic.

The insurance industry has played – and will continue to play – an important role in these risk-based conversations. The industry has access to an enormous volume of data and has increasingly hired experts in earth science, geoscience, actuarial analysis, and other data-driven backgrounds into the field. Being able to combine this scientific expertise with brokers, underwriters, and analytical experts that develop tools such as catastrophe models or other data visualization products, puts the industry in excellent position to provide key commentary on future mitigation strategies.

Risk will never go away. How we collectively work together to implement lessons learned from highly complex catastrophe years such as 2020 will prove critical in the future. As new risks emerge, such as cyber terrorism, it is inevitable that a multi-faceted approach is taken as the world learns to cope with these compounded and connected extremes that affect increasingly large populations around the world.

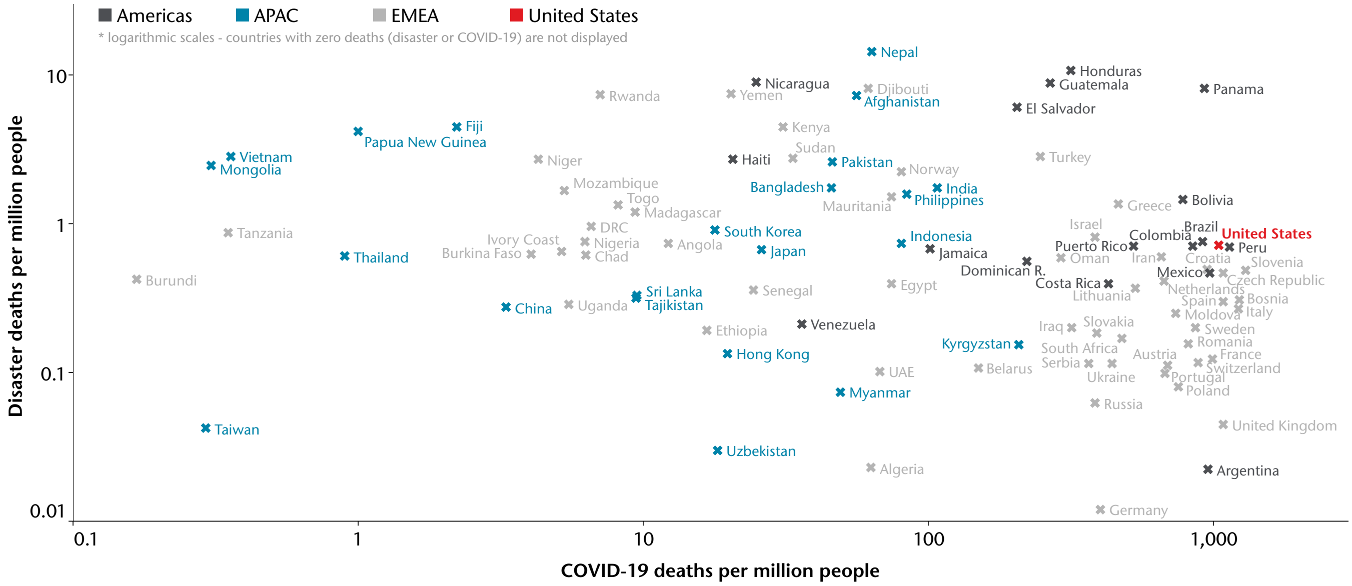


Exhibit 21: COVID-19 & Natural Disaster-Related Fatalities in 2020

Data: Aon & COVID-19 Data Repository by the Center for Systems Science and Engineering (CSSE) at Johns Hopkins University

Reducing Uncertainty in Natural Catastrophe Data

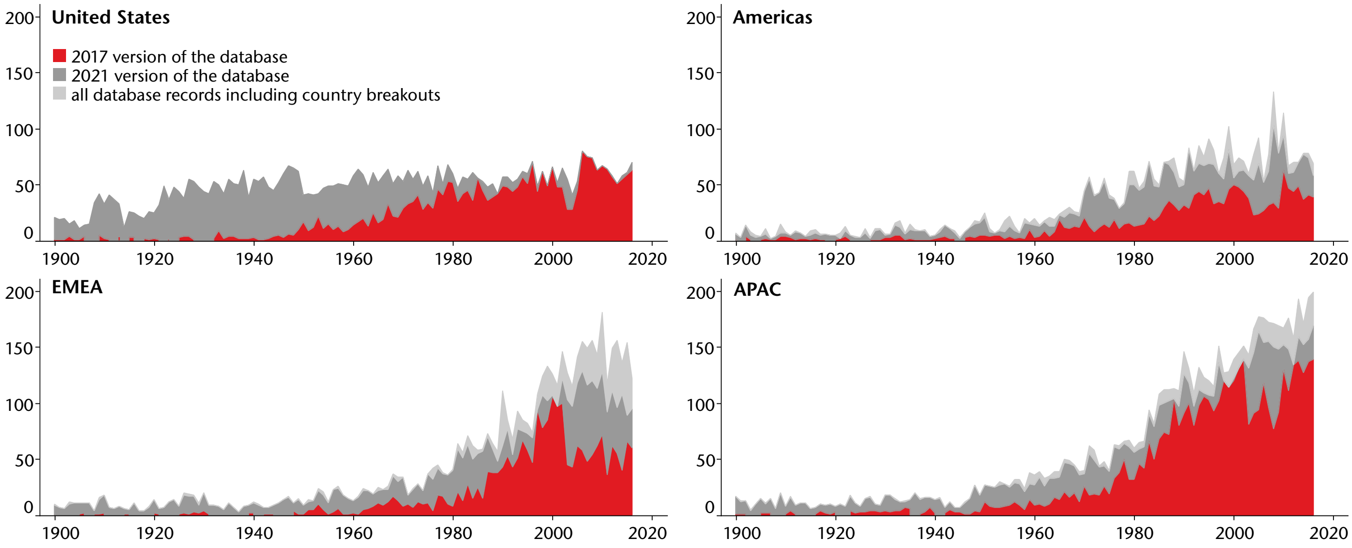
Since the release of the 2018 Weather, Climate & Catastrophe Report, Aon's Catastrophe Insight team has utilized a new historical natural disaster dataset. Through a highly detailed and ongoing research process – more commonly referred to as "Reanalysis" – this has helped fill in data gaps in many regions around the world. Some countries, like the United States and various other developed nations, have much more detailed and prolonged data records available. Most countries, however, do not and this has led to other datasets with incomplete views of historical events beyond a few decades.

It is generally understood that most natural disaster databases show a significant decline in the number of annual global events prior to 1980. While the biggest events are typically captured, most small and medium-sized events have been missed. Aon's data reanalysis process has certainly not completely removed the data gap, but has undoubtedly made major progress in identifying a large portion of events not previously catalogued. The dataset primarily comprises events since 1950, but has a long record of events dating into the 19th Century. The multi-year research has included the local translation of decades' worth of government datasets, newspaper accounts, and journal publications.

Some noteworthy highlights of the reanalysis process include:

- A **continuous, ongoing, multi-year process** that aims to compile the most comprehensive natural catastrophe database available
- Applies a **systematic approach** to targeting official estimations of direct economic and/or insured losses
- Includes official data sources from countries that are largely **underreported in other disaster databases** including sources in foreign languages and those previously never catalogued
- Allows a **more detailed & longer timescale** for global trend analyses beyond the most recent decades
- A **fully transparent** approach by releasing and updating economic loss estimates in our Monthly & Annual reports so users can see loss development in real-time
- Robust view of **insured losses** combines payouts by the private insurance market and public insurance entities such as the NFIP or USDA Crop Insurance program in the U.S. or other similar international programs

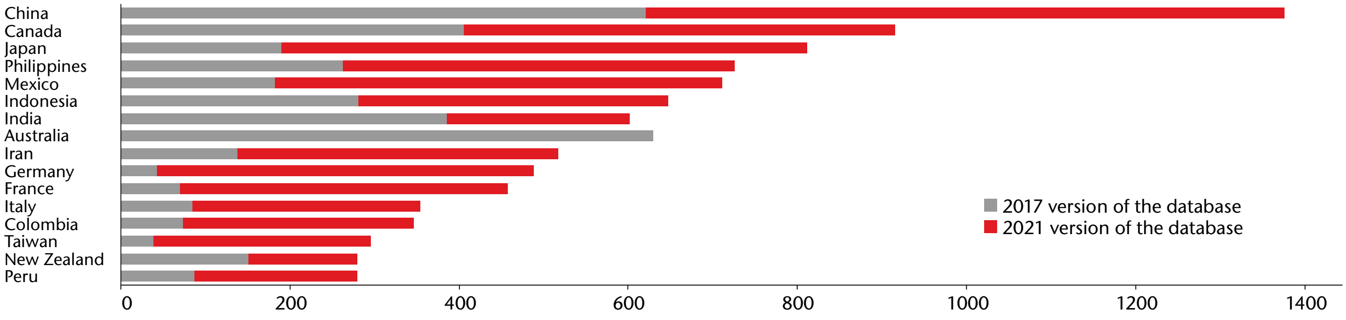
Exhibit 22: Number of Events Per Year & Per Region in the Catastrophe Insight Database



Data: Aon (Catastrophe Insight)

Along with the addition of events that were not previously included in the database, while most focus is often on the aggregate-level, there has been a significant effort has been made to ensure a full country-level breakout of event losses. In many instances, peril events such as tropical cyclones, flooding, European windstorm, winter weather, etc. can have a footprint impacting numerous countries or territories during its life cycle. The loss breakout helps identify trends beyond the peril aggregate and down to a more regional or localized level. The **United States** has the most events in our database. Research since 2017 resulted in database entries for the period of 1900-2016 growing from 3,370 to 6,770 in early 2021. This eliminated recency bias for the country, which is still a challenge for other regions beyond the early 21st Century. Exhibit 23 shows countries with the most non-U.S. event entries for the same period. Note: Event entries in the Catastrophe Insight Database must meet at least one of the criteria listed on page 13. By strictly following this rule, it can result in a reduction of entries if certain event data cannot be confirmed / verified. Australia is one such example with event reduction.

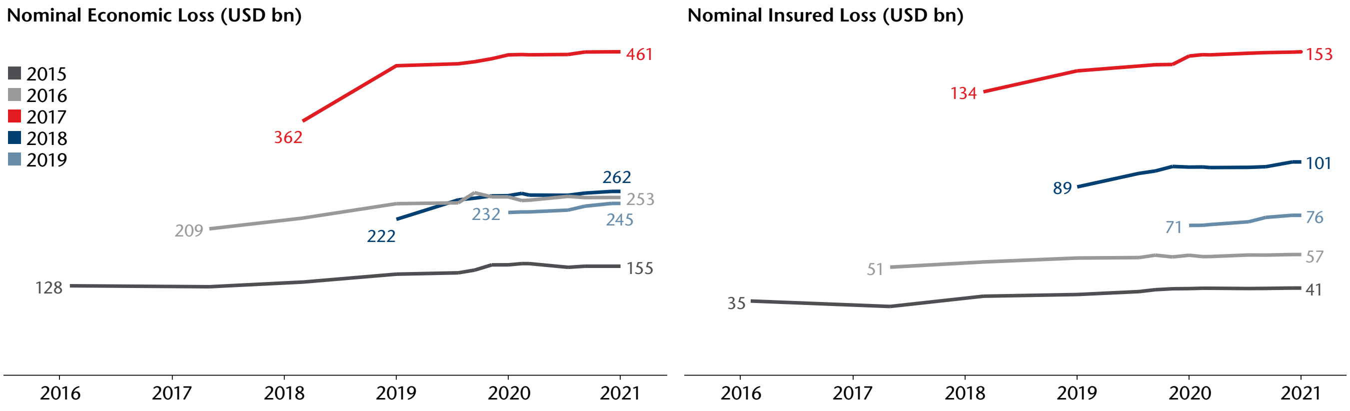
Exhibit 23: Select Example of Non-U.S. Database Entries by Country 1900-2016



Data: Aon (Catastrophe Insight)

The Catastrophe Insight team puts a heavy emphasis on updating existing event records as new data is identified. The “final” event loss total can dramatically change from its initial estimation extended over a multi-year period. The combination of topics like loss creep, claims litigation, Assignment of Benefits (AOB), higher replacement costs or demand surge, delayed releases of official damage estimates, or agency releases on a quarterly / annual basis can all explain why losses may update years after event occurrence. In a year like 2020, unplanned challenges such as COVID-19 can bring more complexity to the post-event assessment process. For example, since the release of the “Weather, Climate & Catastrophe Insight: 2019 Annual Report”, the nominal insured loss for 2019 increased from USD71 to 76 billion. What caused such an increase? Updated data and new research that brought the number of disaster events from 409 to 420. Country-level breakouts grew from 616 to 694. Specific event examples for insured loss growth: Hurricane Dorian increased from USD3.07 to 3.45 billion, Typhoon Faxai from USD6.0 to 6.5 billion, and the Australian Bushfires (bucketed as a 2019 event) from USD1.1 to USD1.6 billion.

Exhibit 24: Nominal loss progression for the last five years



Data: Aon (Catastrophe Insight)

Focus Topic: Tropical Cyclone

Atlantic Ocean

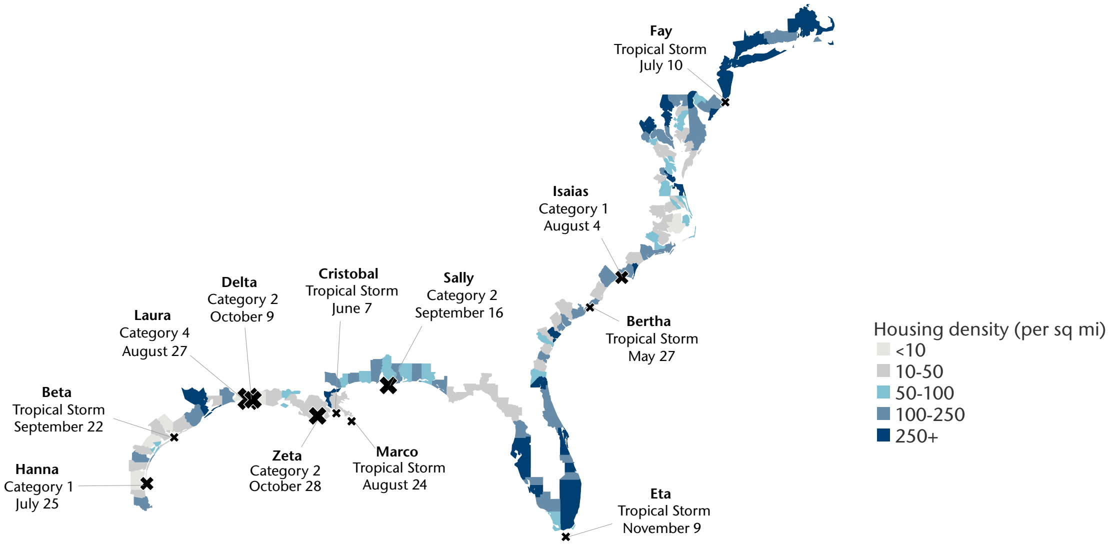
The 2020 Atlantic Hurricane Season re-wrote the record book. The basin produced a record 30 named storms, surpassing the previous maximum of 28 set in 2005. The 30 storms exhausted the conventional alphabetical list of 21 names (letters Q, U, X, Y and Z are excluded) and shifted to the Greek alphabet for just the second time in recorded history. Of the 30 named storms, 13 became hurricanes and 6 reached major hurricane status (Category 3+). The 13 hurricanes marked the second-highest seasonal number dating to 1851; only behind the 15 in 2005. The 6 major hurricanes joined 2017, 2004, 1996, 1950, 1933, and 1926 for the second-most in a season; only behind the 7 in 2005. The season was fueled by near-record warm sea-surface temperatures in the Tropical Atlantic and Caribbean, combined with below average wind shear anomalies. A transition to La Niña amplified conditions for cyclogenesis. The season resulted in Accumulated Cyclone Energy (ACE) reaching 180. ACE is a metric that accounts for storm and/or seasonal intensity and longevity.

A record twelve named storms made landfall in the continental United States, eclipsing the old record of nine set in 1916. The Gulf Coast was particularly affected with nine named storm landfalls, of which a record five were in Louisiana. Hurricane Laura was the costliest landfalling hurricane, generating economic losses of USD18 billion.

While August and September are typically peak months in the Atlantic Basin, some of the most significant activity in 2020 occurred in October and November. Seven named storms, five hurricanes, and four major hurricanes formed during that two-month period. The four major hurricanes were a basin record in October / November. This included twin Category 4 storms, Eta and Iota, that made landfall along the northern Nicaraguan coast within a two-week stretch in November. Eta, the second costliest storm of the season, generated economic losses exceeding USD8 billion, a majority of which was incurred in Central America and went uninsured. Iota was the final named storm of the season, and briefly became a Category 5; the latest calendar occurrence of a Category 5 in the Atlantic on record. 2020 became a record fifth consecutive year with at least one Category 5 Atlantic storm.

Though not wanting to diminish the substantial humanitarian and financial impacts, the 2020 Atlantic Hurricane Season was also rather lucky. Despite the U.S. recording a record number of landfalls, three of the six hurricanes came ashore in areas with some of the lowest population and housing densities along the U.S. East and Gulf coasts: Hanna (Kenedy County, lowest density in Texas) and Laura/Delta (Cameron Parish, lowest density in Louisiana). Nearly all major coastal metropolitan areas were largely unaffected by 2020 storms.

Exhibit 25: 2020 U.S. Tropical Cyclone Landfalls & Housing Unit Density by County



Data: U.S. Census Bureau

Northwest Pacific Ocean

While the Atlantic Ocean had record activity in 2020, it was a much quieter year in the Pacific Ocean. In what is typically the most active global basin for tropical cyclones, the Northwest Pacific Typhoon Season was well below normal. Just 23 named storms formed, including 12 which reached typhoon status, per the Joint Typhoon Warning Center (JTWC), the basin's climatology from 1981-2010 was 26 named storms and 17 typhoons. The Northwest Pacific recorded fewer named storms (23) than the Atlantic (30), marking just the fourth time since 1950 that this has occurred (2005, 2010, 2011, 2020). The aggregate ACE value for the season amounted to just 149 units – substantially lower than the 30-year average (307). The reduced number of storms in the Northwest Pacific was attributed to ENSO conditions transitioning to La Niña during the year. Similar reductions in basin activity was observed in previous La Niña transition seasons in 1998 and 2010.

The season started extremely late with the first named storm (Vongfong) forming on May 8. Only one named storm followed in June, and perhaps even more remarkable, there were no named storms in July. This was the first such occurrence since reliable records began in 1950. Despite the reduced activity, there were several notable storms. Super Typhoon Goni unofficially became the strongest landfalling tropical cyclone ever recorded globally when it struck the Philippines with 195 mph (315 kph) 1-minute average sustained winds. South Korea was impacted by three consecutive typhoons (Bavi, Maysak, Haishen), which exacerbated significant flooding across the peninsula. Haishen additionally left a multi-billion-dollar damage bill across Japan. Vietnam also endured several storm landfalls which resulted in more than USD1 billion in collective flood and wind-related impacts. China endured one of its quietest typhoon seasons in years, with only two typhoons making landfall at Category 1-equivalent (Hagupit and Mekkhala).

Total seasonal economic losses were roughly USD10.5 billion. This marked the lowest seasonal losses for the Northwest Pacific Ocean since 2010 (USD4.5 billion). It also represented a substantial decrease from the USD40 billion incurred in each of the two preceding seasons in 2018 and 2019. Those two years also marked the two costliest back-to-back years for typhoon-related payouts by the Japanese insurance industry, led by storms Jebi, Hagibis, Faxai, and Trami.

North Indian Ocean

The 2020 North Indian Ocean cyclone season registered a total of five named storms, of which four attained hurricane-equivalent status before making landfall. Three of these five storms made landfall at hurricane-equivalent intensity, including two in India (Amphan and Nisarga) and one in Somalia (Gati). The three hurricane-equivalent landfalls marked the third-consecutive year for the basin for this number of occurrence; tied for the most dating to 1990. Seasonal ACE topped 26; slightly above the climatological norm of 19.

The first cyclone of the season, Amphan, was the most catastrophic: a one-time Category 5-equivalent storm that gradually weakened as it approached the India / Bangladesh border in mid-May. It struck as a Category 2-equivalent and caused extensive damage in both countries. The USD15 billion in economic damage made Amphan the costliest North Indian cyclone in the modern record. The other notable cyclone in India was Nisarga. That system made landfall just south of Mumbai on June 3 and became the strongest storm to hit the Indian state Maharashtra during the month of June. Though not a named system, a tropical low came ashore in Andhra Pradesh in October and enhanced regional rainfall that resulted in extensive flooding. Karnataka and Telangana states were also affected as damage costs reached into the low-digit billions (USD). Away from India, Cyclone Gati set a 12-hour rapid intensification record and eventually became the strongest storm on record to strike Somalia (Category 2).

South Pacific Ocean

The 2020 South Pacific Ocean cyclones season (which ran from July 1, 2019 to June 30, 2020) was marked by one of the singular most intense cyclones on record in the basin. Cyclone Harold attained Category 5-equivalent winds just after crossing Vanuatu's Espritu Santo island (becoming the second-strongest cyclone to ever strike Vanuatu; second only to 2015's Cyclone Pam). Harold would later track very near the Fijian Islands and Tonga. The storm caused extensive damage (USD607 million), most of which occurred in Vanuatu (USD440 million). At the end of calendar year 2020, though technically part of the 2021 season, another Category 4-equivalent storm (Cyclone Yasa) struck Fiji. The one-time Category 5 – and earliest on record for the basin – left significant damage on Vanua Levu.

Tropical Cyclone Records & Factoids of 2020

Atlantic Ocean

- 2020 marked the sixth consecutive year with the first named storm developing prior to June 1
- A record 30 named storms formed in the Atlantic Ocean, surpassing the previous record of 28 set in 2005
- Twelve named storms made landfall in the continental United States, eclipsing the old record of nine set in 1916
- Five named storms struck the U.S. state of Louisiana; a state record
- Hurricane Laura tied the record for the strongest Louisiana landfall, with maximum sustained winds of 150 mph (240 kph)
- Ten storms underwent rapid intensification, defined as an increase in maximum wind speeds of at least 35 mph (55 kph) over a 24-hour period, tied for most in a single Atlantic Ocean season
- Hurricane Iota was the latest calendar year Category 5 hurricane in the Atlantic Basin since 1851 (November 16)
- Sub-tropical Storm Alpha was the easternmost forming named storm on record in the Atlantic Ocean, and the first named storm to make landfall in Portugal
- A record of four major hurricanes formed in the Atlantic Basin after October 1 (Delta, Epsilon, Eta, Iota)

Pacific & Indian Oceans

- Super Typhoon Goni struck the Philippines with 195 mph (315 kph) winds; unofficially the strongest tropical cyclone landfall ever recorded in the world
- Amphan became the strongest storm on record in the North Indian Basin during the month of May; 160 mph (260 kph)
- Nine hurricane-equivalent landfalls in the North Indian Basin from 2018-2020; highest three-year stretch since at least 1980
- Cyclone Gati struck Somalia as a 105 mph (165 kph) Category 2; strongest storm on record to strike Somalia
- Cyclone Harold made landfall on Vanuatu with 155 mph (250 kph) winds; second strongest storm to ever strike the island
- Cyclone Yasa became the earliest Category 5 storm on record during the South Pacific Ocean Cyclone Season (December 16)

2020 Global Tropical Cyclone Review

Exhibit 26: 2020 Global Tropical Cyclone Activity by Basin compared to climatology*

Basin	Named Storms		Hurricanes		Major Hurricanes		ACE	
	2020	**Climo**	**2020**	**Climo**	**2020**	**Climo**	**2020**	**Climo**
Atlantic	30	12.1	13	6.4	6	2.7	179.8	105.6
East Pacific	16	16.7	4	8.9	3	4.3	76.5	132.1
West Pacific	23	25.9	12	16.7	6	8.9	148.5	307.3
North Indian	5	4.9	4	1.5	2	0.7	26.2	19.1
Northern Hemisphere	74	59.5	33	33.6	17	16.6	431	564.1
South Pacific	10	9.7	5	5.0	1	2.3	59.7	71.0
South Indian	17	16.2	9	8.7	3	4.5	84.1	134.7
Southern Hemisphere	27	26.0	14	13.7	4	6.8	143.8	205.9
Global	**101**	**85.6**	**47**	**47.3**	**21**	**23.4**	**574.8**	**769.9**

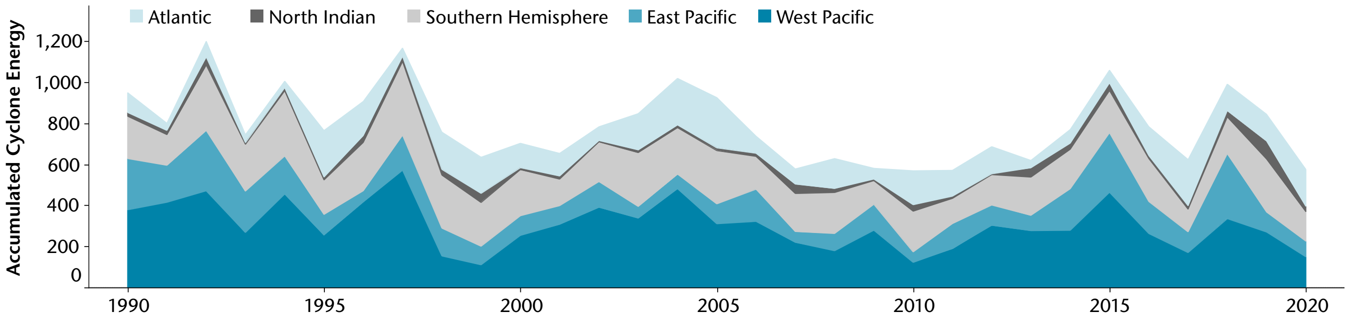
**Compared to the 1981-2010 climatological average. The 2020 Southern Hemisphere season ran from July 1, 2019 to June 30, 2020.*
Source: National Hurricane Center; Joint Typhoon Warning Center; Colorado State University

Global **Accumulated Cyclone Energy (ACE)** values were well below the climatological norm in 2020. In fact, the 575 ACE was the lowest global total since 2011 (571) and only one of seven years since 1980 to not record an ACE value of at least 600. The Atlantic Ocean Basin produced the highest ACE of any basin (180). This marked the fifth time since 1980 that the Atlantic had the highest ACE.

ACE is a useful metric for tropical cyclone analysis in that it helps better clarify the intensity and longevity of a specific storm or season. The general trend of ACE values since 1990 has been largely flat; a negative 0.85 percent annual rate of growth. This suggests that seasons have not shown any statistically significant change. It also confirms that the overall frequency of storms has not changed much over time.

However, there are some patterns beginning to emerge when looking a bit deeper into storm behavior. This is also where climate change influence is becoming more apparent. As warmer oceanic and atmospheric conditions become conducive for more instances of rapid intensification cycles and/or storms maintaining maximum intensity for longer periods of time, it is expected that the storms which do develop have the potential to be larger, more intense, and pose a greater risk to coastal and inland vulnerabilities. The past three decades has resulted in an increasing percentage of hurricanes becoming high-end, Category 4 or 5 storms. The decadal breakout includes: 1990-99 (35 percent); 2000-09 (38 percent); 2010-19 (42 percent). The preliminary 2020 breakout was 33 percent; subject to seasonal reanalysis.

Exhibit 27: Global Accumulated Cyclone Energy (ACE)



Data: Colorado State University

Rapid Intensification

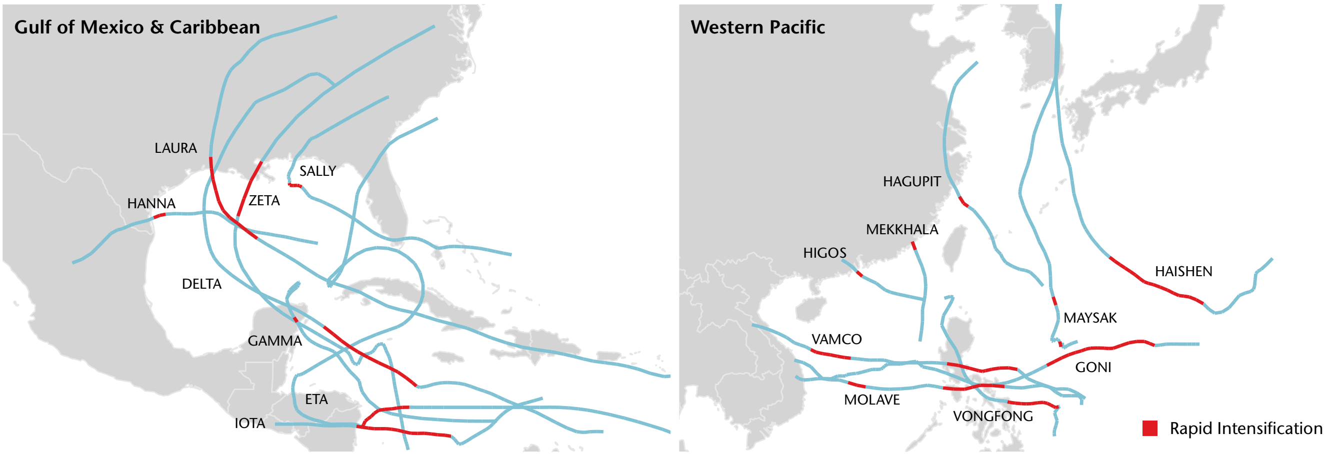
Perhaps the most notable aspect of tropical cyclone activity in 2020 involved individual storm behavior. As noted earlier in Exhibit 28, while overall global activity was near normal, the expedited rate by which many storms intensified continued to account for a sizable portion of the total number of systems. In fact, of the 101 named storms that underwent cyclogenesis, nearly one-third (31) went through a phenomenon known as rapid intensification (RI). The official definition of rapid intensification is when a storm strengthens by at least 35 mph (55 kph) during a single 24-hour period. A record-tying 10 storms underwent this process in the Atlantic Ocean in 2020. This tied the 1995 Atlantic season, but more storms in 2020 went through more extreme strengthening. Ten of the 13 Atlantic hurricanes recorded a period of RI, including two storms (Eta and Iota) which intensified by an astonishing 80 mph (130 kph) in a single 24-hour period. In both instances, the RI occurred as the storms traversed extremely warm waters in the Caribbean Sea as they neared the Nicaraguan coastline. Even more remarkable is that both of those storms occurred in the month of November; when Atlantic cyclogenesis tends to notably reduce as less favorable oceanic and atmospheric conditions establish.

Multiple questions emerge in the aftermath of the 2020 season: 1) Is this behavior part of a growing trend of global tropical cyclones intensifying at faster rates; 2) When/where is the intensification occurring? 3) How well do numerical weather prediction models capture rapid intensification cycles? 4) What is the role of climate change?

An increasing volume of scientific literature has been published in recent years that has tried to put these rapid intensification trends into historical and future perspective. Most of these analyses have been focused on the Atlantic Ocean Basin since this is where the highest quality long-term data with the least amount of uncertainty exists, though the Northwest Pacific Ocean has also been studied. Storm trends during the past three decades have shown more RI across most global tropical cyclone basins. This includes more storms recording RI and at a more pronounced rate. This greater frequency of RI events is likely most directly tied to natural variability (such as ENSO, the Atlantic Multi-decadal Oscillation, Pacific Decadal Oscillation, etc.), but as oceans continue to warm at a faster rate, at deeper depths of the ocean, and at higher latitudes, the impact from climate change is also expected to become more prevalent with time.

The other concerning component of RI occurrence is that it is happening closer to coastlines prior to landfall, as opposed to open oceanwaters far from land. This is highly concerning given the increased risk to life and property as coastal populations continue to grow. Adding further challenge is that the quality of intensity forecasting by numerical weather prediction models remains far behind their ability to forecast track. Federal governments and academia around the world continue to heavily invest in resources to reduce uncertainty and improve computational track and intensity performance. As storms grow stronger in the future, it will be critical to qualify and quantify the risk for those potentially in harm's way.

Exhibit 28: Rapid Intensification of Landfalling Tropical Cyclones in the Atlantic and Western Pacific Basins in 2020



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[2] *Bhatia, K.T., Vecchi, G.A., Knutson, T.R. et al. Recent increases in tropical cyclone intensification rates. Nat Commun 10, 635 (2019).* https://doi.org/10.1038/s41467-019-08471-z

[3] *Emanuel, K. Will Global Warming Make Hurricane Forecasting More Difficult? Bulletin of the American Meteorological Society 98, 3;* https://doi.org/10.1175/BAMS-D-16-0134.1

[4] *Jinjie Song et al 2020 Environ. Res. Lett. 15 084043;* https://iopscience.iop.org/article/10.1088/1748-9326/ab9140

Fusing catastrophe modeling and climate science for more realistic climate risk scenarios

Catastrophe modeling has historically been conducted primarily in the private sector, while academia and government scientists have taken the lead on the science of climate change. This has generally worked well in previous decades. However, it has left blind spots in our ability to fully understand climate risk, and the time to fix those is now.

Most mainstream climate science focus has been on averages across the largest space and time scales. While there has been ample academic research on how extreme events are changing, the results have not necessarily been "plug and play" for the re/insurance industry. Changes in return periods for events of a given magnitude, for example, are not typically found in our research papers.

For its part, the re/insurance industry has been slow to recognize the need to incorporate climate science. The argument has been that because contracts are written one year at a time, climate change can be priced as it happens. Thus, catastrophe models can continue to be closely based on the historical record without explicitly incorporating predictive climate science. To properly price climate risk, though, we have to detect and attribute the climate change signal in extreme weather. We cannot do that using history alone, because there's too much "noise" from natural variability.

To understand how climate change is influencing losses, we need to untangle the climate change signal from the noise. Climate science gives us some tools, but we need to build more.

To represent climate change itself, we need earth system models, such as those in the ongoing Sixth Coupled Model Intercomparison Project (CMIP6). But those models generally do not well represent extreme weather events, so we need careful "downscaling" on their results. That means building catastrophe models that are climate-sensitive: include output from climate models that describe the changing climate and generate extreme weather events that are consistent with those changes. For these models to be credible, they should be based on open, peer-reviewed research.

The science here is at the bleeding edge. The uncertainty involved is larger than what the industry is used to, but also a different type. Scientists in re/insurance will need to learn about climate sensitivity, multi-model ensembles, emissions scenarios, and other things outside of their past practices. At the same time, more scientists in academia and government need to understand the nature of risk, and why a lot of our work doesn't address it. Particularly, much academic work does not focus tightly enough on extreme event probabilities.

The climate crisis demands a broad range of solutions. Re/insurance will play a critical role, but for it to fulfill its potential, both the underlying science and the way the industry uses that science needs to evolve. The best path forward is insurance, academia, and government working together to see past the blind spots and develop realistic climate scenario-based solutions.

__Adam Sobel__ is professor at Columbia University's Lamont-Doherty Earth Observatory and Engineering School

Focus Topic: Severe Convective Storm

Costliest Peril for Insurers

While tropical cyclones often generate the greatest number of headlines, the most consistently impactful – and sometimes costliest – peril is severe convective storm (SCS). Perhaps a surprise to many, but SCS has been costlier than tropical cyclone for the re/insurance industry in 22 of 31 years since 1990. A deeper dive into the data helps provide more clarity as to why this is true. Tropical cyclone payouts tend to show tremendous volatility on an annual basis. Major spikes in years such as 2004, 2005, and 2017 skew the mid- and long-term averages for the peril, since the highest tropical cyclone years are higher than those of SCS, but it masks the underlying fact that SCS has much more annual consistency. The standard deviation for SCS from 1990-2020 was USD9 billion. This compares with a much higher USD28 billion for tropical cyclone.

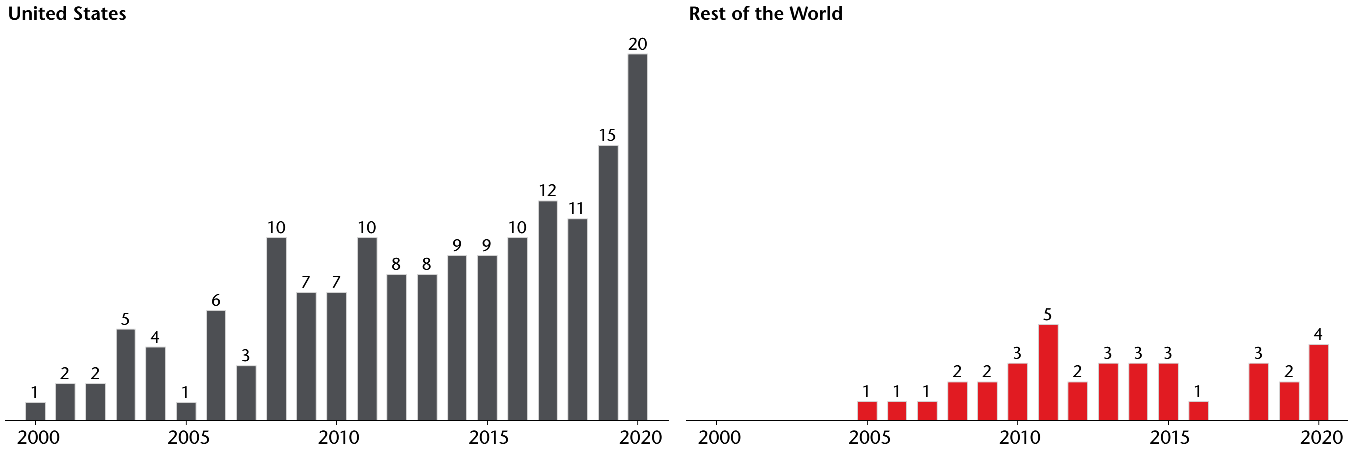
SCS maintained its status as a primary loss driver in 2020. It was again the world's costliest peril for the insurance industry. Of note, while an expensive year for insurers, this did not directly translate into major payouts by reinsurers. Despite the high cost from thunderstorms, the frequency of the events played a bigger role than the cost of individual events. This means that a higher volume of medium-sized insurance events did not lead to a significant portion of those costs being ceded (transferred to be paid) by reinsurers since written triggers were not met. SCS continues to be an increasingly costly peril for insurers. One question moving forward will be whether the increased frequency of these medium-sized events leads to more aggregate excess cover in the future that would allow insurers more protection.

United States

The United States endured its costliest year for severe convective storms on record in 2020; surpassing the previously historic year in 2011 that featured prolific tornado outbreaks. The U.S. also withstood a record 14 individual billion-dollar economic loss SCS events. All but two resulted in billion-dollar insured losses, including four which were multi-billion-dollar industry events. It marked the 13th consecutive year which public and private insured SCS losses topped USD10 billion, and just the second time that payouts exceeded USD30 billion. The most significant event of the year occurred on August 10 in the Midwest. One of the most destructive derecho events on record resulted in more than USD11.0 billion economic damage – of which USD7.0 billion was insured – to property and agribusiness across the hardest-hit states of Iowa, Illinois, and Indiana. This was the second-costliest U.S. disaster of 2020 regardless of peril.

The Storm Prediction Center (SPC) preliminarily tallied 1,248 tornado touchdowns. At least 24 of those were rated either EF3 (18) or EF4 (6). The U.S. has not recorded an EF5 tornado since May 2013; the longest such streak since NOAA began keeping tornado statistics in 1955. There were 25 tornadoes which resulted in 78 fatalities. This was the highest annual fatality total since 2011 (553). The deadliest tornado occurred on March 3, when an EF4 tornado swept through Putnam County, Tennessee. This tornado sequence also prompted an EF3 tornado that tracked through the greater Nashville metro region and caused more than USD1.5 billion in damage alone. This became one of the top six costliest U.S. tornadoes on record.

Exhibit 29: Number of SCS events that caused insured losses above USD500 million



Data: Aon (Catastrophe Insight)

Australia

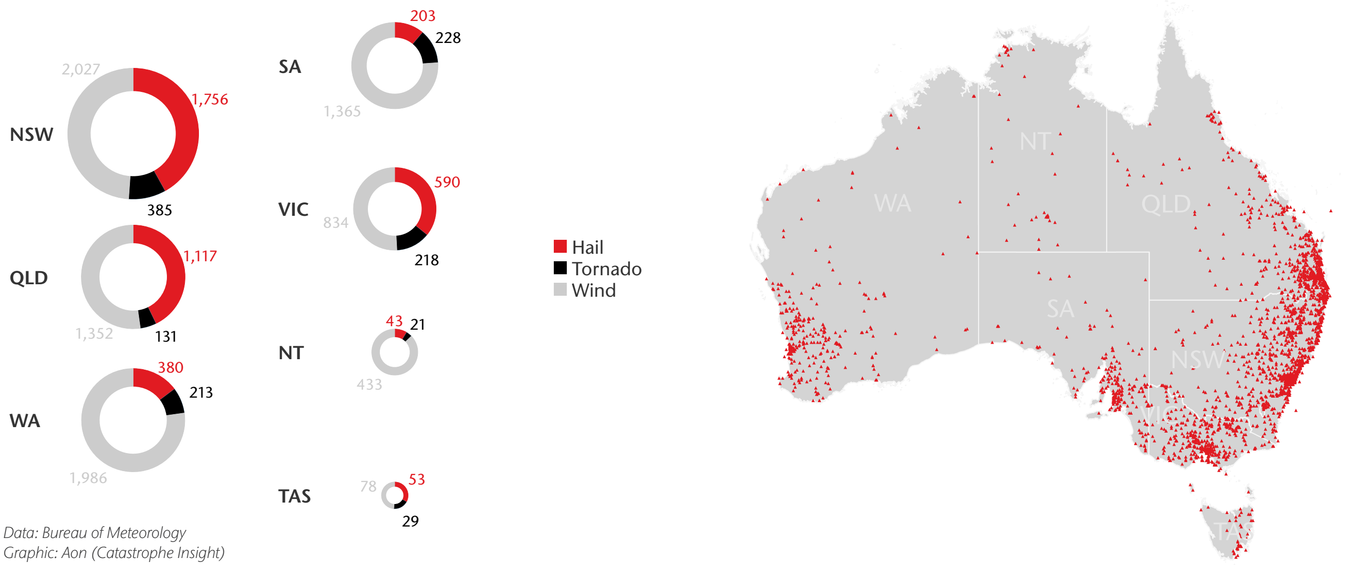
There was no other region outside the U.S. that incurred more SCS damage than in Australia in 2020. Based on available insurance data from the Insurance Council of Australia (ICA), Perils AG, and various other public sources (including agricultural interests), the industry paid out nearly USD3.5 billion (AUD4.7 billion) in storm-related claims. Total economic losses were even higher at nearly USD5 billion (AUD6.5 billion). There were four distinct and significant events that affected various parts of the country in 2020: a series of hailstorms that affected parts of the Sydney, Brisbane, and Melbourne metro regions (January 19-20); a powerful East Coast Low that prompted severe weather and flooding in Queensland and New South Wales (February 4-11); a series of major hailstorms in Eastern Queensland (April 19); and a series of major hailstorms on Halloween in Queensland's Brisbane region (October 31).

Australia is one of the most active regions in the world for thunderstorms; similar to other parts of North America, South America, Asia, and Europe. While tornadoes and non-tornadic winds are common, especially in rural areas of the country with minimal population, the most damaging sub-peril for the insurance industry from these convective storms typically comes from hail. Especially since high-frequency hail areas tend to coincide with dense population and exposure. Severe thunderstorms can occur at any time of year, but they most frequently happen during the Southern Hemisphere spring and summer between the months of September to April.

Annual variability in spatial occurrence is common in conjunction with various large scale atmospheric patterns identified in the Southern Oscillation Index (OCI) and/or El Niño-Southern Oscillation (ENSO) phases, but the intensity is not. The regional topography of Australia, especially along the East Coast in New South Wales and Queensland, makes the country highly conducive for thunderstorms. When combining the effects of maximum daytime heating and various interactions with sea breezes or frontal boundaries, this can lead to rapid destabilization of the atmosphere and powerful thunderstorms capable of producing hail larger than the size of grapefruits (4.5 inches (11.4 centimeters).

The challenge for Australia is that a majority of the population live in communities located within close proximity to the coast: Sydney, Melbourne, Brisbane, Canberra, Adelaide, or Perth. These areas have a long history of costly hail events, many of which have crossed the billion-dollar threshold. In fact, the costliest insurance industry event in Australia's history was the April 1999 Sydney metro hailstorm. The ICA notes that if the event were to occur today, it would result in USD4.3 billion (AUD5.6 billion) in insured payouts. Enacting mitigation strategies via retrofitting properties with better performing roofs or siding will not fully eliminate risk, but can help reduce future costs. The adage "spend money to save money" remains true. As population densities grow, the importance of strategic investment around hail risk will increase along with it.

Exhibit 30: Australia Severe Weather Climatology & Hail Report Map (1900-2019)



Data: Bureau of Meteorology
Graphic: Aon (Catastrophe Insight)

What is the “Derecho” Phenomenon?

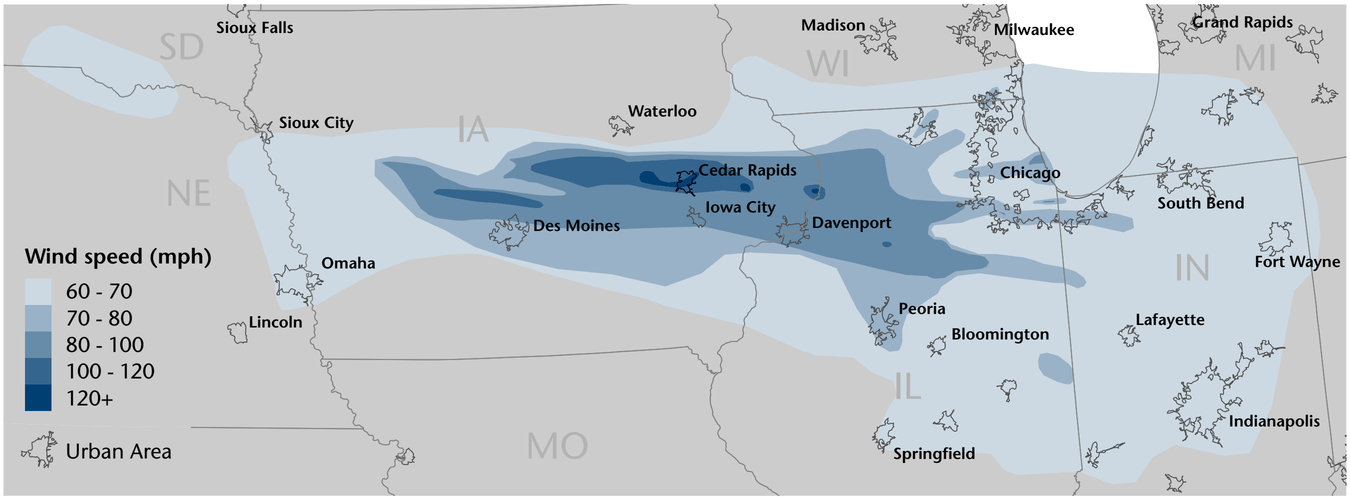
If you ask a casual observer who had just endured a significant burst of wind and subsequent damage during a thunderstorm event to describe their experience, the most frequent response is “That was a tornado!”. The reality is that in many, if not most, cases the impacts were due to powerful downbursts or straight-line winds. These are instances when an extreme rush of air from the top of a thunderstorm cloud pushes down to the surface. Such winds do not have any rotational spin and typically traverse in a singular direction. This is the type of wind that is defined by a “derecho”. The term “derecho” originates to a paper published in the *American Meteorological Journal* by Dr. Gustavus Hinrich in 1888. The Spanish term, which means “straight” or “direct”, was used to describe the type of winds and resultant damage from an event that affected the U.S. state of Iowa in July 1877.

NOAA officially defines a derecho as a widespread, long-lived wind event associated with a band of rapidly moving thunderstorms. These storm clusters must track a minimum of 250 miles (400 kilometers) and be accompanied by wind gusts topping 60 mph (95 kph). In the strongest derechos, such as the August 10, 2020 U.S. Midwest Derecho, peak wind gusts reach up to 140 mph (220 kph). This is equivalent to an EF3 tornado. Derecho events generate their fast forward motion due to very strong mid/upper level winds via the jet stream or frontal boundary influence. Isolated tornadoes within embedded individual storm cells are also common. The damage cost to residential and commercial property, insurers, and local governments can often exceed USD1 billion.

There are multiple types of derechos, though regardless of type, the fast forward speed can greatly reduce preparation time and catch unsuspecting residents by surprise. Perhaps the most well-known derecho type is the “Progressive Derecho”. Such an event is one that typically occurs in warm season environments where hot airflow and moisture wrapping around the outer periphery of a ridge of high pressure initiates thunderstorm genesis. This pattern is more frequently known as the “Ring of Fire”. The August 10, 2020 U.S. Midwest Derecho is an example of a Progressive Derecho. The most frequent type, accounting for roughly 40 percent of all derechos, is the “Serial Derecho”. These events usually occur in cool seasons such as the spring and develop ahead of a leading frontal boundary. The defining feature of a “Serial Derecho” is an elongated squall line, of multiple clustered squall lines, that spatially extends more than 250 miles (400 kilometers). Perhaps the most famous example occurred on March 12-13, 1993 during the U.S. “Storm of the Century”.

Most derechos are found in the United States, though they more commonly affect areas east of the Rocky Mountains. Derecho climatology indicates that such events occur at least once a year, but if atmospheric conditions are ripe, they can happen multiple times in short succession. While the U.S. is the most associated region for derechos, they can develop in many other parts of the world. Portions of Europe (including Germany), South Africa, China, Argentina, and Brazil have all recorded derecho events in recent years. In eastern India and Bangladesh, these events are referred to as “Nor’westers”.

Exhibit 31: August 10, 2020 U.S. Midwest Derecho Wind Footprint[1]



[1] *Includes tornado swaths in Illinois, Wisconsin and Indiana. Data: NOAA*

Focus Topic: Wildfire

Primary Focus on a Secondary Peril

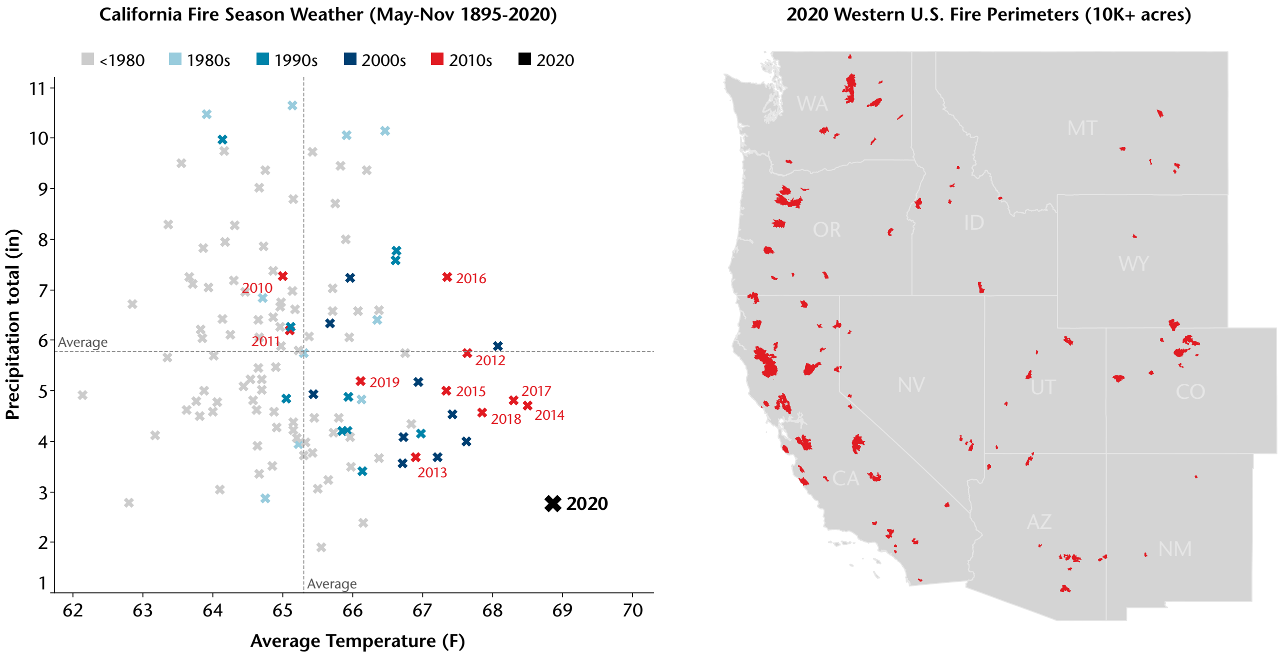
Secondary perils have become an increasingly important topic for various sectors ranging from the insurance industry to local governments to investment strategists. Such perils, which often generate small to medium-sized financial damage costs, include severe convective storms, floods, wildfires, winter weather, etc. Primary perils, those thought to be best understood to have the highest cost potential, include tropical cyclones and earthquakes. Severe Convective Storm typically generates most interest with secondary perils given a higher frequency of occurrence, but wildfire has become an increasingly important point of focus. 2020 marked the third time in the last four years where global insured losses from wildfires exceeded USD10 billion. This is a threshold that the peril had never crossed prior to 2017.

The United States has often been the primary driver of major wildfire impact to residential and commercial property in recent years given prolific events in California, but Australia and Canada have also recorded billion-dollar industry event payouts in the past decade. More questions are being asked as to why these fire losses are becoming more frequent and expensive. The answer, unfortunately, is a complex one that scientists and communities are trying to collectively solve.

There is increasing evidence that the environment for wildfires has become more conducive for conflagration. Numerous studies have shown that in the United States, South America, and elsewhere around the world that land temperatures continue to rise, drought conditions are more intense, and fire seasons are becoming longer. Exhibit 32 below shows how fire season weather conditions in California have grown drier and warmer since 1895. In fact, 2020 was the warmest May through November stretch on record and set the stage for a modern state record for most acres burned in a season dating to the early 1980s. This also included five of the six largest fires in California since 1932. Ancillary factors like reduced fire suppression or beetle infestation has left much more available fuel to burn as dead trees or brush lay scattered in forested areas that have a history of fire activity.

While climate change is not the primary cause of increased fire risk, it has absolutely proven to be an important influencing factor on the basic hazard itself. Attribution studies, which attempt to link climate change to individual events, are becoming more common. Early results are generally inconclusive in being able to accurately quantify the hazard impact and then define that attributed economic cost.

Exhibit 32: California Fire Season Weather & 2020 Western U.S. Fire Perimeters



California Fire Season Weather (May-Nov 1895-2020)

2020 Western U.S. Fire Perimeters (10K+ acres)

Data: NOAA & National Interagency Fire Center (NIFC)

While the environmental conditions are a critical and highly concerning component to fire behavior and spread, the fact remains that the ignition, fire location, and the vulnerability of the community remain most integral regarding risk to life and property. The human component grows more important by the day. From an ignition standpoint, a non-negligible percentage of fires are ignited by either intentional or unintentional human behavior. The other factor is where humans live and how we continue to build. If migration patterns into known fire locations grow, and not enough fire suppression is done to minimize ground level spread, this is a very difficult trend. Population totals in the Wildland Urban Interface (the divide between urban and forested areas) or the Intermix (directly inside a forested area) continue to increase on an annual basis in California.

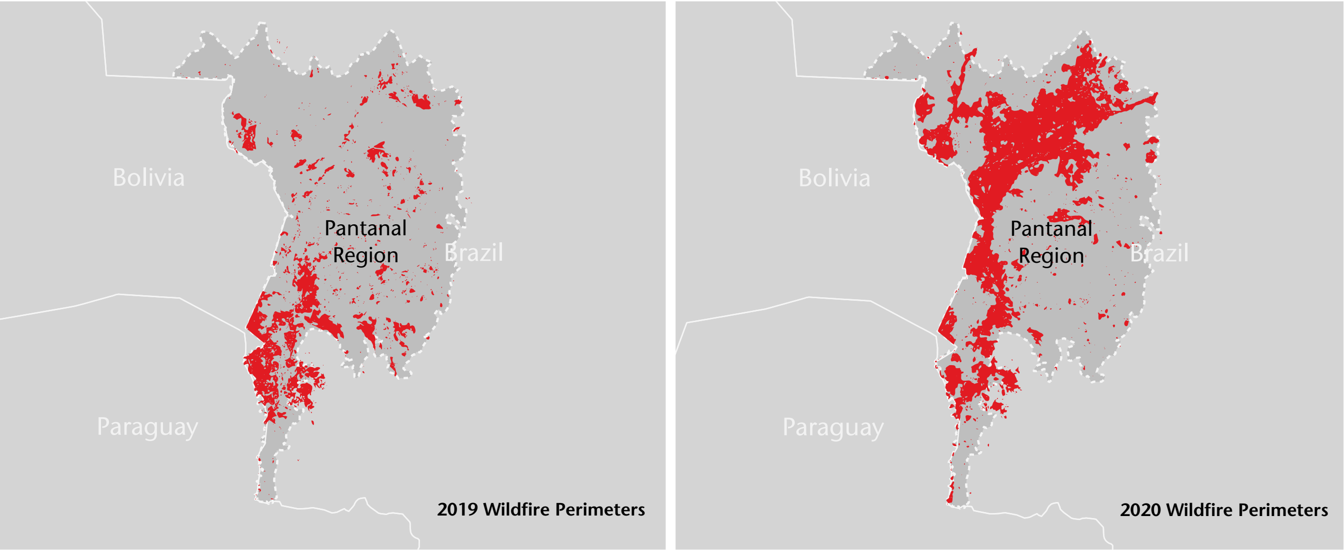
The other issue is a need for better and smarter construction and maintenance practices. Taking simple actions, such as installing fire resistant roofing or clearing potentially combustible materials away from a property, can immediately lower risk. The need for community "buy-in" is key, as even one vulnerable building that catches fire can quickly ignite an entire neighborhood. Organizations such as the Insurance Institute for Business and Home Safety (IBHS) in the United States and the Institute for Catastrophic Loss Reduction (ICLR) in Canada are examples of important collaborative efforts between the public and private sectors to mitigate risk from various natural perils. Wildfire risk will only grow with time. Awareness of this risk is an important first step. Enacting smart mitigation strategies is what is needed next.

South America

Wildfires have always been a complex challenge in South America. Most fires are a direct result of human behavior via deforestation, logging, mining, and other types of land clearing practices. These fires are typically conducted intentionally and illegally as local farmers, cattle ranchers or other industries seek to open up lands for fiscal opportunity. Back-to-back years in 2019 and 2020 have resulted in substantial burning in some of the most vital aspects of the Amazon Rainforest. The Amazon is a critical component in mitigating global warming by being the world's largest terrestrial "carbon sink" which helps absorb carbon for an indefinite period of time and can reduce harmful carbon dioxide concentration in the atmosphere.

The fires of 2020 were particularly significant given the substantive spatial area burned. The combination of intentional burning while parts of Brazil, Bolivia, Paraguay, and Argentina coped with La Niña-influenced severe drought conditions prompted rapid wildfire spread. The main areas affected included the Brazilian and Bolivian Amazon, Argentina's Parana Delta wetlands, the Gran Chaco forest, and the Pantanal wetlands. In the Brazilian Amazon alone, more than 2.7 million acres (1.1 million hectares) of land was lost from August 2019 to July 2020; a 9.5 percent increase from the previous period and the highest level in more than a decade. The Pantanal wetland region burned even more area: 11.1 million acres (4.5 million hectares). This was an 84 percent year-over-year increase, per the Laboratory for Environmental Satellite Applications (LASA).

Exhibit 33: Brazil Pantanal Region Wildfire Perimeters (2019-2020)



Data: Brazil's Laboratory for Environmental Satellite Applications (LASA)

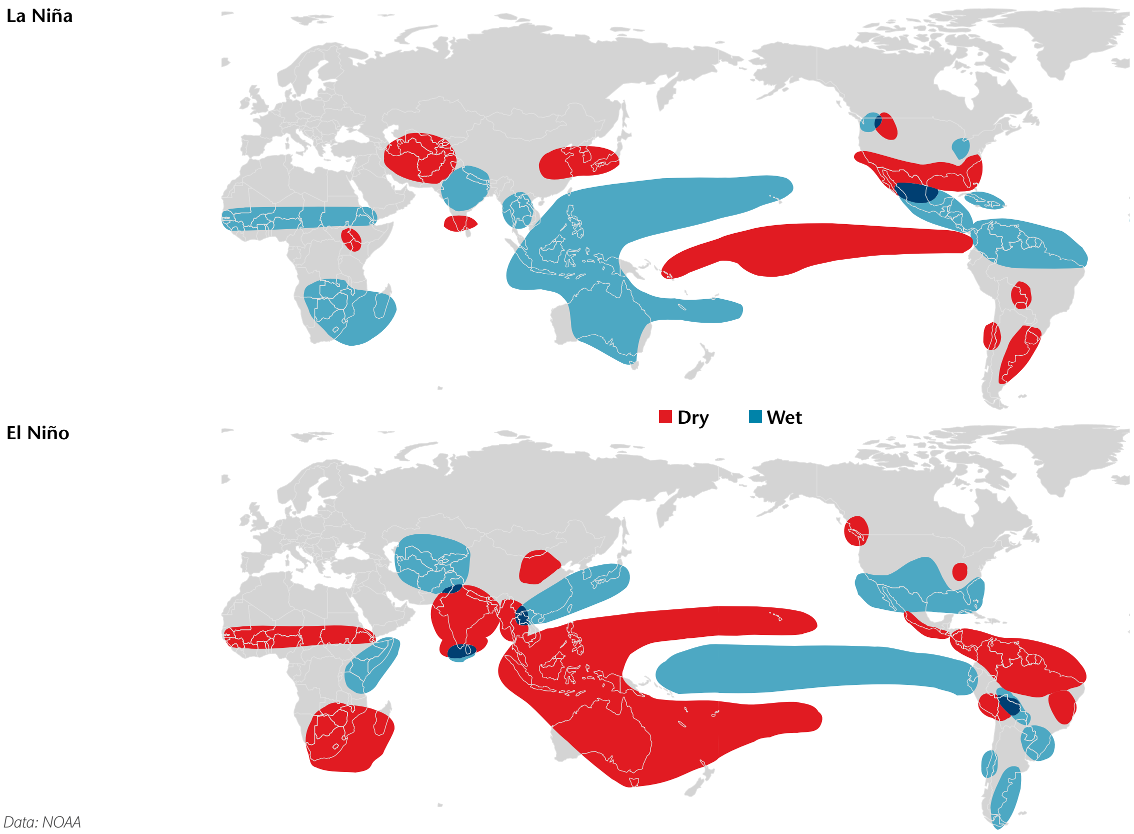
Focus Topic: Flooding

ENSO's Effect on Rainfall Patterns

The El Niño-Southern Oscillation (ENSO) is a very important and influential climate-related phenomenon. The ENSO footprint is found in most areas of the world and has a direct effect on various weather-related perils. This is especially true regarding rainfall patterns, including regional seasonal monsoons. 2020 marked a transitional year from ENSO-neutral conditions to a La Niña, which eventually had implications on rainfall extremes in Asia and Africa (excess precipitation via the seasonal monsoon) and the United States (major drought following a lack of a Southwest Monsoon season). As a reminder, an ENSO event is characterized by the anomalous sea surface temperature conditions in the central and eastern equatorial Pacific Ocean. A positive (negative) ENSO phase, also known as an El Niño (La Niña), occurs when sea surface temperatures are warmer (colder) than the climatological mean.

The regional influence of ENSO on rainfall or precipitation patterns can be quite different between each phase. Exhibit 34 below visually shows the spatial and temporal differences. Some of the most significant impacts are often found in Asia based on ENSO influence on seasonal monsoon patterns. The monsoon, which is characterized by copious rainfall in tandem with changes in prevailing wind flow, is the most important weather pattern for many Asian countries. In fact, monsoon rains can account for more than 80 percent of a country's entire annual rainfall. These rains often drive domestic socioeconomic health in a calendar year, and any enhancement or reduction in totals can have severe financial consequences. For a country like China, the combination of La Niña and excessive monsoon rain can lead to flood damage reaching into the tens of billions (USD) – as seen in peak loss years of 2020, 1998, and 2016. India, Pakistan, Bangladesh, Indonesia, and Vietnam are additional countries that have recorded peak flood losses based on ENSO phase.

Exhibit 34: ENSO Phase Relationship with Global Rainfall



Data: NOAA

Asian Monsoon

The transitional shift from ENSO-neutral to La Niña played a pivotal role for the various Asia monsoon seasons in 2020. Some of the hardest-hit areas included China, India, Bangladesh, Pakistan, Vietnam, Japan, and the Korean Peninsula. As alluded to previously, there is a well-documented link between various ENSO phases, and subsequent transitional periods between phases, that can have major influence on precipitation patterns. The financial toll from 2020 Asia Monsoon floods topped USD56 billion, though only a small fraction of this total was covered by insurance due to continued low insurance penetration. The Asian floods accounted for more than 60 percent of the global economic flood cost. More than half of that total was incurred in China, following one of the highest precipitation years on record within the Yangtze River Basin. An enhanced "Mei-yu" seasonal frontal boundary was the primary driver of flooding in not just China, but other East Asian countries such as Japan and the Korean Peninsula.

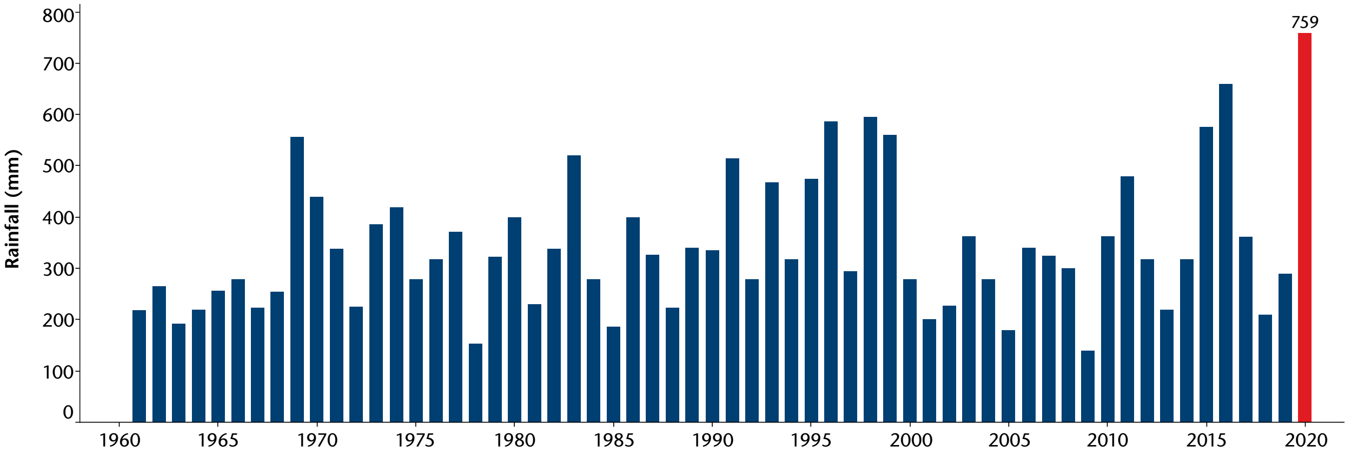
Parts of the Indian Subcontinent also faced substantial precipitation and resultant impacts. India, Pakistan, Bangladesh, and Nepal all cited considerable summer rainfall that caused extensive damage and left thousands of fatalities. Another driving mechanism of flooding outside the monsoon was a series of tropical disturbances or cyclones that prompted additional major flooding. Parts of central India faced successive such storms in mid-October that left billions of dollars' (USD) worth of damage.

African Monsoon

Following a very deadly and costly 2019 from flooding, parts of the African continent again faced heavy and widespread precipitation in 2020. Anomalous warming of the western tropical Indian Ocean near the Horn of Africa was a likely driver of early season flooding from March to May across central and eastern Africa. Hundreds of fatalities and notable damage was recorded. This was likely a remnant impact from an especially strong positive phase of the Indian Ocean Dipole (see the "Weather, Climate, and Catastrophe: 2019 Annual Report" for a deeper look at this analysis).

The West African Summer Monsoon Season commenced in July and lasted through September. A significantly enhanced volume of precipitation was cited in the African Sahel region. Scientific research has suggested that an active monsoon season in the African Sahel region can be an indicator of enhanced tropical cyclone activity in the Atlantic Ocean; this correlated very well in 2020. The rains caused extensive damage and humanitarian impacts in Sudan, Niger, and Nigeria. The primary mechanism in this region is the Inter-Tropical Convergence Zone (ITCZ). Moist winds, both from the equatorial Indian and Atlantic Ocean region, converge along the ITCZ and produce monsoon precipitation in the region. Previous academic studies have shown an increase of monsoon convection over the Sahel region – in tandem with the propagated location of the ITCZ – and greater modulation of sea surface temperatures in the Indian and Atlantic Oceans during La Niña phases of ENSO.

Exhibit 35: Total average rainfall in the Yangtze River Basin during the monsoon season



Data: China Meteorological Administration, National Climate Center

Focus Topic: Additional Perils

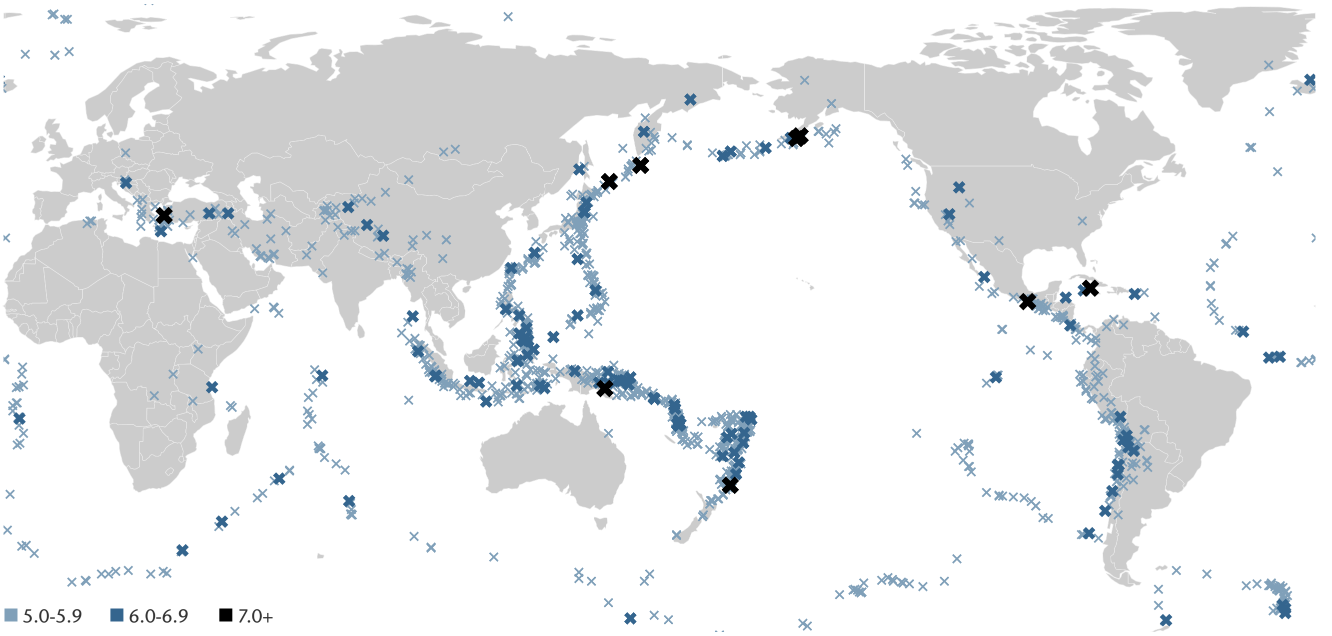
2020 featured many other notable peril events. Despite being the first year since 2016 without a magnitude-8.0 or greater **earthquake**, there were multiple newsworthy tremors that left widespread damage. One of the costliest natural disasters of the year was a magnitude-5.3 temblor that struck Zagreb, Croatia on March 22. A government report cited direct economic damage at USD12 billion, though some uncertainty exists with that figure as it also includes full reconstruction costs in today's standards. Another major earthquake struck Central Croatia on December 29. The magnitude-6.4 tremor severely damaged the town of Petrinja and the adjacent region. Elsewhere, during a period from late 2019 into early 2020, a swarm of moderate earthquakes struck southwestern Puerto Rico. Total damage from the tremors topped USD1 billion.

An active slate of **European windstorms** resulted in the costliest calendar year for the peril since 2013. However, roughly half of the USD4.3 billion in insured losses came from Windstorm Ciara (also known locally as Sabine or Elsa). The February storm impacted at least 20 countries during its life cycle, and tied with 2018's Windstorm Friederike as the costliest peril event since Windstorm Xynthia in 2010 (USD3.6 billion). The only additional windstorms which resulted in at least USD200 million in insured losses included Dennis (USD690 million) and Bella (USD300 million).

While impacts resulting from flood were elevated, global **drought** costs were much more muted. The peril accounted for only USD10 billion in economic damage; the lowest for the peril since 2007. Nearly one-third of the 2020 losses were attributed to the United States. The arrival of La Niña aided in severely reduced precipitation across the western half of the U.S., which resulted in the largest portion of the Lower 48 States to be in "Extreme" or "Exceptional" drought conditions since 2012, according to the U.S. Drought Monitor. A multi-billion-dollar economic cost from drought conditions was also found in parts of South America (especially Brazil, Argentina, and Paraguay), where harvest yields were reduced. In Asia, parts of China recorded damage tallying to USD2.4 billion.

Perhaps the quietest of the "main" perils in 2020 was **winter weather**. The USD4 billion in economic costs due to property or agricultural damage was the lowest annual total for the peril since 2002. Only one-quarter of those costs were insured. Europe and China accounted for more than half of winter weather-related economic costs following extended bouts of excessive snowfall and/or periods of below normal temperatures due to a lobe of the Polar Vortex sinking southward from the Arctic Circle. A reminder that a weakening of the Polar Vortex due to warming causes portions or "pieces" to break off and sink southward.

Exhibit 36: Global Earthquake Activity in 2020



Data: USGS

Mitigating Market Shocks and Managing Climate Transition

Corporations, investors, and financial markets hate surprises; yet, when it comes to climate change, science indicates that future environmental conditions will vary in some dimension – from increased fluvial flooding to reduced water supplies. It is no longer strategic to base forward-looking decisions on historical or even present-day conditions.

We see evidence of this already. The 2018 California wildfires, for example, triggered the beginning of what could become an insurability crisis; premiums rose and, were it not for the intervention of the state government, many homeowners would have lost coverage. As the world warms, catastrophic events will increase in frequency and intensity and in ways that are impossible to predict using conventional risk assessment methods.

Hence the need for a new approach; one that combines the benefits of traditional methods, like catastrophe modeling, with new approaches like climate risk and opportunity modeling. These forward-looking, probabilistic models help companies make strategic and risk management decisions under complex and changing environmental conditions. For example, the amount of greenhouse gas emissions released into the atmosphere will continue to affect atmospheric conditions as well as elicit a range of societal responses. This is where scenario analysis becomes so crucial when assessing climate impacts.

Climate scenario analysis is central to understanding climate impacts and undertaking the Task Force on Climate-related Financial Disclosures (TCFD) – reporting set by the Financial Stability Board. This can be incredibly complex as it requires access to terabytes of climate data, scientific expertise to calculate specific hazard metrics, immense computing power, and the ability to pair climate model outputs with asset location to measure potential impacts. Corporations are increasingly turning to analytical tools, such as the Climanomics® platform, to assess both physical and transition risk as well as opportunities over a time horizon of 2020-2100.

Without preparation, all sectors will face unexpected impacts and unprecedented change. For example, in addition to increases in coastal flooding risk around the world, we observe in the data spikes in wildfire risk by mid-century in certain regions that traditionally have had very little exposure, leading to unforeseen damage to property, business interruption, and, perhaps even outmigration of certain areas.

Fundamentally, climate scenario analysis is about minimizing surprises. It is about enhancing risk management by enabling intelligent investment, insurance and planning strategies. As corporations, investors, and governments worldwide embrace the TCFD and begin to mandate climate risk reporting, climate scenario analysis will come to the fore as critically important for businesses to master to prepare and be future-ready.

*By **Tory Grieves**, VP of Analytics for The Climate Service*

2020 Climate Review

Global Temperatures & ENSO

2020 became the second-warmest year on record dating to 1880. Preliminary official data from the National Centers for Environmental Information (NCEI), formerly known as the National Climactic Data Center (NCDC,) indicated that 2020 was 0.98°C (1.76°F) warmer than the historical norm. It was also the 44th consecutive year of above average global land and sea surface temperatures. Temperature anomalies are compared against NCEI's 20th Century average (1901-2000).

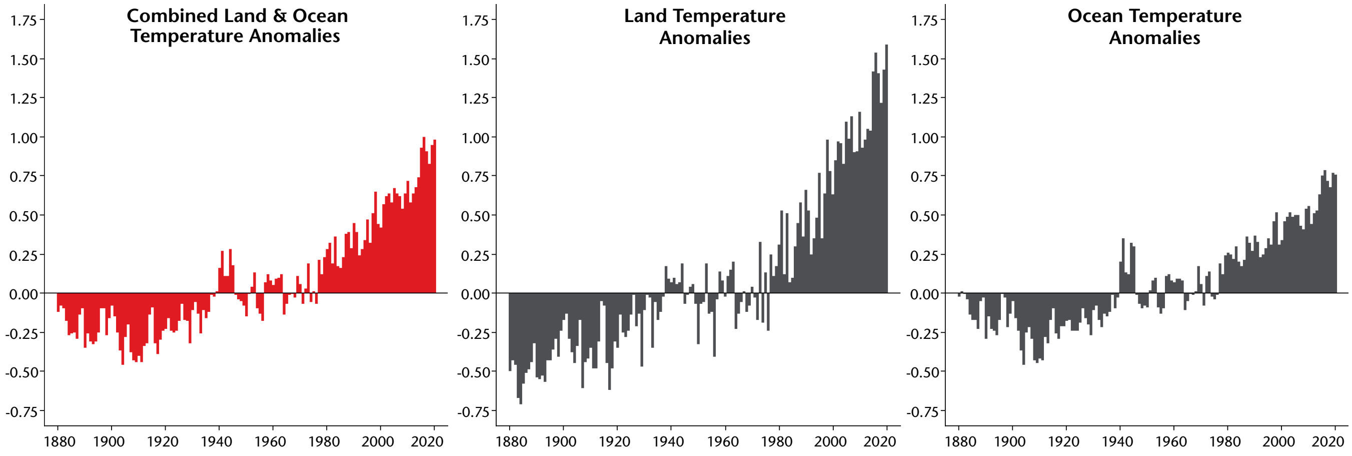
Five of the warmest years on record have occurred in the past six years: 2016, 2020, 2019, 2015, and 2017. Eight of the top 10 warmest years also occurred in the last decade (2011-2020). Perhaps even more striking is that 19 out of the 20 warmest years have been registered since 2001; the lone exception being 1998 when the globe encountered one of the strongest El Niño event on record during the first-half of the year. It was previously assumed that El Niño years would comprise most of the warm year lists since it amplifies warming. The opposite was always assumed to be true for La Niña – meaning that historical data typically shows that the globe tends to cool during such phases – but 2020 still set a record for warmth. This suggests that land and ocean temperatures continue to warm at an accelerated rate regardless of any influence from natural variability or cycles that may occur. An additional point of perspective is that the warmest year in 2016, 1.00°C (1.80°F) is more anomalous than the coldest year in 1904 at -0.46°C (-0.83°F).

To provide further context of the longevity of the earth's warming streak, the last below-average year for the globe occurred in 1976. At that time, global temperatures registered 0.07°C (0.13°F) below the long-term average. The last individual month to be below average was December 1984 at -0.08°C (-0.15°F) lower. As of December 2020, that marked 432 consecutive months with above average global temperatures.

When viewing the temperature trends individually on land and ocean – the rates of growth are pronounced since the last below average combined year in 1976. Land temperatures have shown a +5.3 percent uptick; while ocean temperatures have grown by +3.3 percent. The combined land and ocean increase is +3.9 percent. This is due to oceans having a larger spatial extent than land.

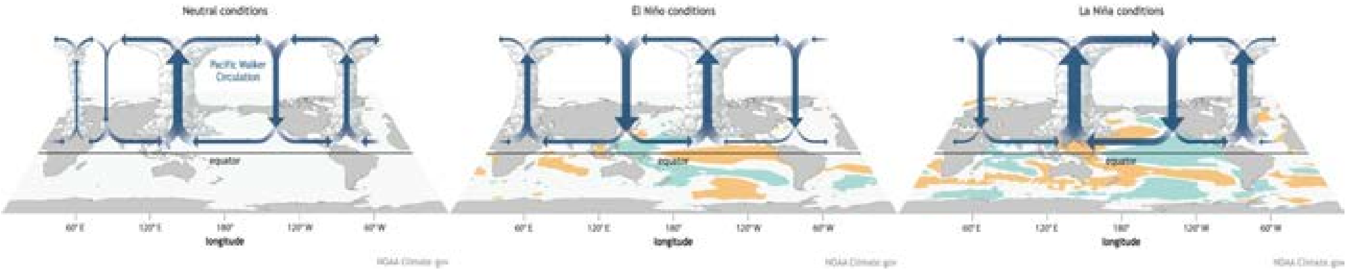
Analyzing global temperature anomaly trends is important to track changes in climate. A temperature anomaly is simply the difference of an absolute (measured) temperature versus its longer-term average for that location and date. All major agencies that independently measure global temperatures use a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

Exhibit 37: Global Land and Ocean Temperature Anomalies: 1880-2020



Data: NOAA

Exhibit 38: El Niño/Southern Oscillation (ENSO)



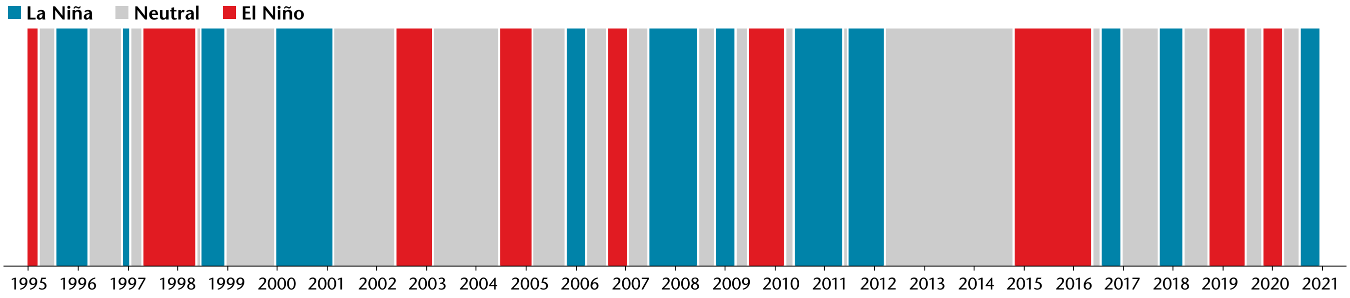
Source: NOAA

There are several different types of seasonal oscillations that can influence regional weather. The one that has a more robust global influence is the El Niño/Southern Oscillation (ENSO): a warming or cooling cycle of ocean waters across the central and eastern Pacific. This often leads to changes in the orientation of various atmospheric patterns and ocean currents. Warming periods are noted as El Niño cycles, while cooling periods are known as La Niña cycles. The Niño-3.4 Index, which measures the temperature of the ocean waters in the central Pacific, is used to determine ENSO phases/cycles.

According to data from the National Oceanic and Atmospheric Administration's (NOAA) Climate Prediction Center (CPC), 2020 was a year initially marked by a weak El Niño conditions before quickly transitioning to a moderate La Niña during the boreal – Northern Hemisphere – summer. This was a driving component of why the 2020 Atlantic Hurricane Season was historically active. For 2021, initial projections by NOAA and the International Research Institute for Climate and Society (IRI) at Columbia University suggest that La Niña conditions would persist through the first half of the new year.

Please note that to be considered in an ENSO phase, NOAA requires a five consecutive, three-month running mean of sea surface temperature anomalies in the Niño-3.4 Region to be +0.5°C (El Niño) or -0.5°C (La Niña). The exhibit below highlights individual monthly conditions. In some instances, individual months may meet the ENSO phase criteria, but do not persist for the five-consecutive month requirement.

Exhibit 39: ENSO Phase Conditions by Month



Data: NOAA

Global Carbon Dioxide

According to data provided by the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory (ESRL), global monthly carbon dioxide (CO_2) levels averaged at least 412 parts per million (ppm) for the first time in the modern record in 2020. Monthly average concentrations on Mauna Loa Observatory in Hawaii in May peaked at more than 417 ppm, while the concentrations did not fall below 411 ppm in any month for the first time, again, in the modern record dating to 1958.

Atmospheric CO_2 levels have a scientifically-proven correlation with global temperature, supported by data from ice cores and the geological record. Concentrations annually peak in May as plants begin to grow in the Northern Hemisphere with the arrival of spring. After peaking, a gradual decline occurs during the month of September as the growing season ends. It is worth noting that the annual rate of growth in CO_2 concentration has been increasing for multiple decades. The annual mean rate of growth of atmospheric CO_2 in each year is the difference in concentration between the end of December and the start of January of that year. If used as an average for the globe, it would represent the sum of all CO_2 added to, and removed from, the atmosphere during the year by human activities and by natural processes. NOAA also applies a 4-month interpolating technique to account for month-to-month variability.

COVID-19 & Carbon Emissions

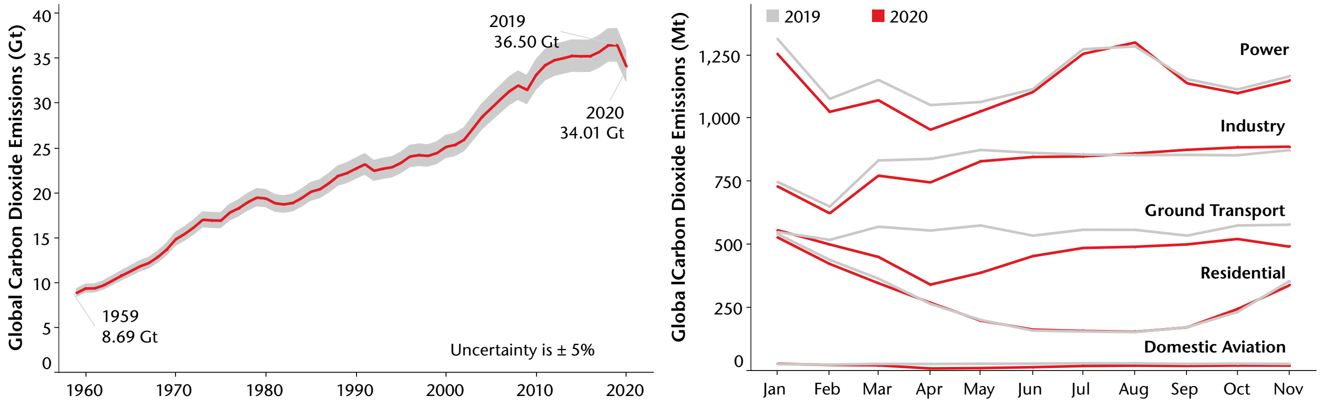
Amid societal and industry restrictions and reductions resulting from the COVID-19 pandemic, global carbon dioxide (CO_2) emissions declined at an unprecedent level throughout 2020.

According to data from the Global Carbon Project (GCP), which relied on a synthesis on four peer reviewed studies, a record global decline in annual CO_2 emissions of nearly 7 percent was expected in 2020. Global emissions were reduced from 36.4 ($GtCO_2$) in 2019 to an anticipated 34.1 ($GtCO_2$) in 2020. Regional median declines for 2020 were projected for China (-1.7 percent), The United States (-12.2 percent), European Union (-11.3 percent), and India (-9.1 percent). Emissions in China were the first to sharply decline early in the year but had since recovered above pre-COVID levels. The GCP annual emissions data extends back through 1959.

The Carbon Monitor (CM) interpreted daily absolute CO_2 emission data comparisons between 2019 and 2020 among the top emitting sectors. Comparisons between the two years indicated a notable emissions reduction in the power, industry, and ground transportation sectors in 2020, which peaked in Q2. As COVID restrictions eased in many locations, a trend toward pre-COVID levels resumed across all sectors except for ground transportation.

Once emitted, CO_2 in the atmosphere does not readily dissipate, resulting in a substantial lag between reduced emissions and atmospheric concentrations. Congruently, burning of fossil fuels results in a net increase to the reservoir of global atmospheric CO_2. The relatively large natural seasonal cycles in atmospheric CO_2 discussed earlier are superimposed on the long-term increasing trend. While emissions reduction of nearly 7 percent in 2020 was evident across monthly and seasonal atmospheric CO_2 cycles, it does not correspond to an equivalent change in global atmospheric CO_2 over short time scales.

Exhibit 40: Global CO_2 emissions and Comparison of monthly sector emissions in 2019 & 2020



Source: CDIAC; Friedlingstein et al 2020; Global Carbon Budget 2020

Source: Liu et al 2020; https://carbonmonitor.org/

Arctic Sea Ice

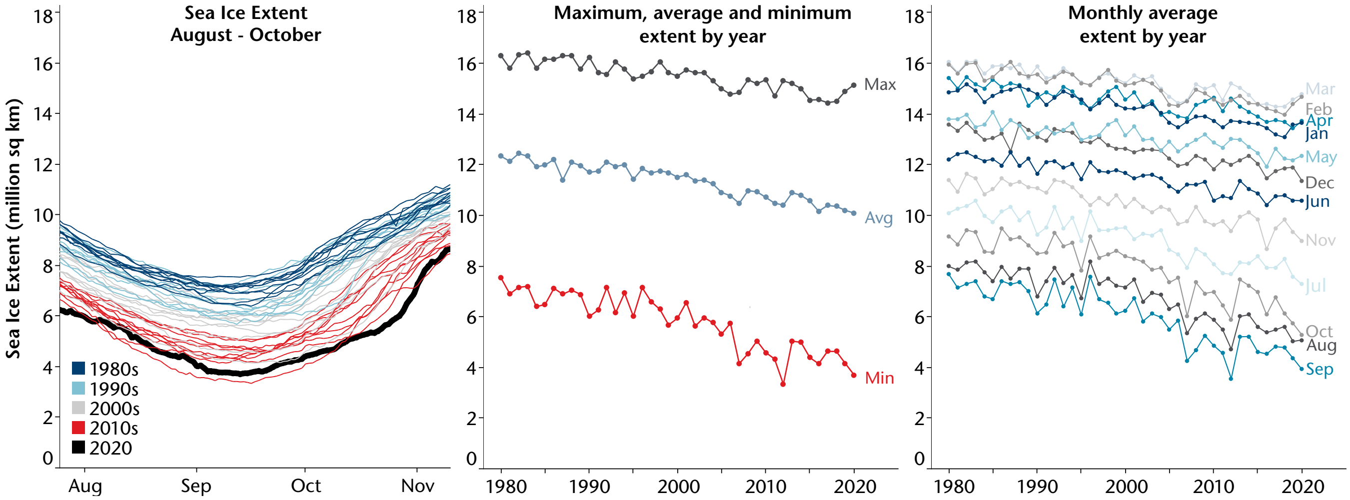
The notable decline of the Arctic Sea Ice extent and volume in recent years has been well documented. This is an important topic given the impact it has on essential climatic feedback mechanisms that affect global circulation patterns. Surface air temperatures in the Arctic region have been increasing at a rate twice as fast as the rest of the globe, with far-reaching impacts for the entire Arctic ecosystem. Some of these impacts include a reduction in natural habitats, but also increased accessibility of the Arctic Ocean for shipping since some areas no longer freeze at any point of the year.

In a concerning trend, satellite data from NASA and the National Snow and Ice Data Center (NSIDC) showed that 2020 became the second-lowest year for minimum Arctic sea ice extent when the coverage shrunk to just 3.74 million square kilometers (1.44 million square miles) on September 13. It represents a 2.49 million square kilometer (0.96 million square mile) reduction from the 1981-2010 September climatology. This was only behind the 3.34 million square kilometers (1.29 million square miles) recorded on September 16, 2012. It is worth noting that the last year which Arctic sea ice extent was above climatology occurred in 2001. of above-average September extent was in 2001. The official modern satellite dataset extends to the late 1970s.

The summer months were generally characterized by high pressure located over Greenland and parts of the Arctic Ocean, with frequent warm air transferring across Siberia and Alaska. The speed of the seasonal decline in July and August was particularly high and not dissimilar to what occurred in 2012. Daily minimum extent records were set throughout 2020, with monthly minimum extents ranking in the top 5 for 2020 from April to December. July featured its lowest minimum extent in the official record. Open water pathways persisted in the Chukchi and Beaufort Seas and in Baffin Bay towards the end of the year. Scientific feedback in the most recent IPCC "Special Report on the Ocean and Cryosphere in a Changing Climate" showed high confidence that Arctic sea ice cover will continue to shrink during the 21st Century.

While an important metric, sea ice extent does not tell the complete story regarding the health of the Arctic and Antarctic circles. Age and depth of sea ice is perhaps an even more critical component to this type of analysis. Younger and thinner ice permits more heat to escape into the atmosphere. This in turn causes Arctic and Antarctic air and sea surface temperatures to warm. Analyses show that the average age of Arctic ice has significantly decreased in the last few decades.

Exhibit 41: Arctic Sea Ice Extent: 1980-2020



Fetterer, F., K. Knowles, W. Meier, M. Savoie, and A. K. Windnagel. 2017, updated daily. Sea Ice Index, Version 3. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. doi: https://doi.org/10.7265/N5K072F8. [1/1/2021]

Annual Climate Extremes

Daily station data from NOAA's GHCN (Global Historical Climatology Network) allows us to visualize anomalous monthly global weather and climate events during 2020. Exhibit 42 below indicates stations which tied or broke a monthly record of maximum or minimum temperature and/or accumulated precipitation total. The final dataset only included stations which had a total record length of at least 30 years with 90 percent or higher data completeness during the most recent 30-year period.

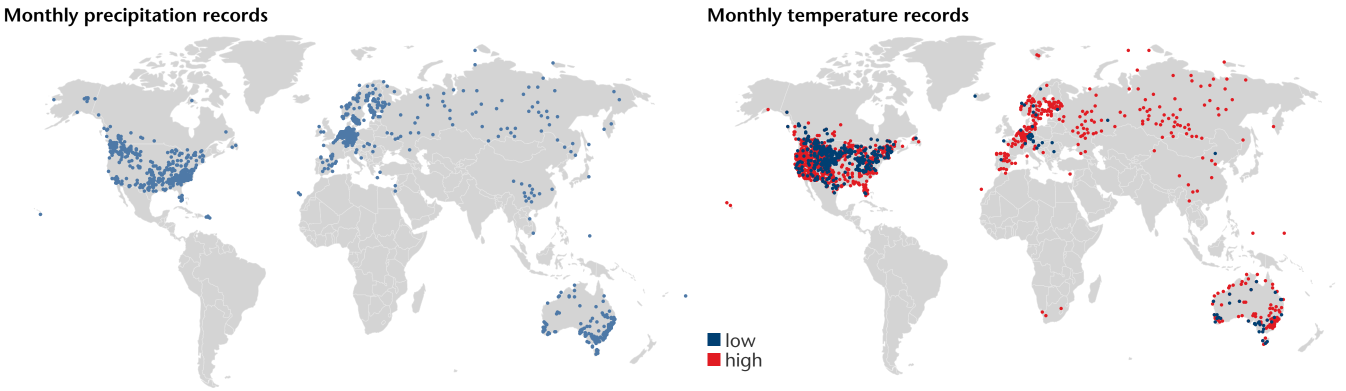
It is important to note that the GHCN dataset contains weather and climate observations from 180+ countries and is updated daily. However, the spatial and temporal coverage is not uniform and there are notable gaps in data availability in several parts of the world. The highest concentration of stations with the longest and most complete records are primarily located in the United States, western Europe, and Australia; with the lowest station concentrations in Africa and South America. While this is not a perfect dataset, it does help begin to identify any emerging trends in various parts of the globe.

In 2020, a total of 4,601 stations met the completeness criteria for temperature. For maximum temperature, 1,449 unique stations tied or broke a monthly record during 2020, of which 448 had a record length of at least 100 years and 487 reported a record in more than one month. Overall, 104 stations reported an all-time station maximum temperature during the year. For minimum temperature, 470 unique stations tied or broke a monthly record during 2020, of which 111 had a record length of at least 100 years and 87 reported a record in more than one month. Overall, two stations reported an all-time station minimum temperature during the year.

A total of 7,992 stations met the completeness criteria for precipitation. For total accumulated precipitation, 1,210 unique stations tied or broke a monthly precipitation record during 2020, of which 204 had a record length of at least 100 years and 112 reported a record in more than one month. Yearly station records were reported at 86 stations, highlighting a particularly wet year across portions of western Canada and the Appalachian Mountains of the United States.

As the calendar turned to 2021, a reminder that this also signifies the beginning of a new set of climatological norms. Climate normals are evaluated every 10 years and reflect the average of climatological variables such as temperature, precipitation, and snowfall during the most recent 30-year period. A 30-year period ensures a statistically reliable estimate of the average values. The new climate normals, which officially began in 2021, encompass the period between 1991 and 2020.

Exhibit 42: Monthly temperature and precipitation records broken or tied in 2020



Data accessed on January 11, 2021
Data: Global Historical Climatology Network (GHCN)

United States

Exhibit 43: Top 5 Most Significant Events in the United States

Timeframe	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
August 21-19	Hurricane Laura	Plains, Southeast	33	18.0 billion	10.0 billion
August 8-12	SCS (incl. Midwest Derecho)	Midwest	4	12.6 billion	8.3 billion
September 14-18	Hurricane Sally	Southeast	8	7.0 billion	3.5 billion
August 3-6	Hurricane Isaias	Mid-Atlantic, Northeast	15	4.8 billion	2.7 billion
September 27-October 5	Glass Fire	California	4	4.0 billion	2.9 billion
		All Other Events	~186	73 billion	46 billion
		Totals	**~250**	**119 billion[1]**	**73 billion[1,2]**

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

119 bn

Total Economic Losses (USD)
48% above average since 2000

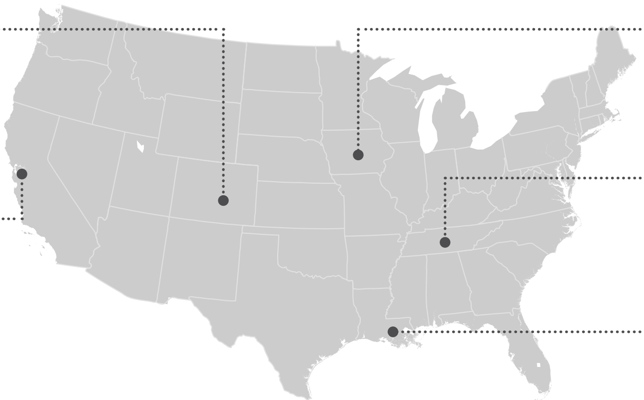
73 bn

Total Insured Losses (USD)
82% above average since 2000

44%
Portion of Global Economic Losses

76%
Portion of Global Insured Losses

62%
Portion of losses covered by insurance



Western U.S. Wildfires
2.5M acres burned
(CO, OR, WA)
4,500+ destroyed structures
Insured Loss: USD3 billion

California Wildfire Season
4.2M acres burned
10,488+ destroyed structures
Insured Loss: USD8.8 billion

August 10 Midwest Derecho
Economic Loss: USD11 billion
Peak wind gust: 140 mph
in Cedar Rapids, Iowa

March 2-3 Tornadoes
EF3 Tornado struck Nashville, TN
Economic Loss: USD1.5+ billion
(Sixth-costliest tornado on record)

Hurricane Laura
Strongest U.S. landfall of 2020
150 mph sustained winds
Economic Loss: USD18 billion

129.9˚F / 54.4˚C
Death Valley, CA (August 16)
Unofficially the hottest global temperature ever reliably measured by instrumentation

30
Number of named storms in the Atlantic Ocean Basin; 40% of those storms (12) made U.S. landfall

22%
Part of the Lower 48 in “Extreme” or “Exceptional” drought (December); Most since August 2012

Economic and insured losses derived from natural catastrophes in the U.S. were substantially above the long-term average in 2020. The overall economic total was estimated at USD119 billion, of which USD73 billion was covered by public and private insurers. When compared to annual data from 2000-2019, economic losses in 2020 were 48 percent above the average (USD80 billion), and 145 percent higher than the median (USD49 billion). Insured losses were 82 percent higher than average (USD40 billion) and 181 percent higher than the median (USD26 billion).

The hyperactive Atlantic Hurricane Season of 2020 resulted in a record 12 tropical cyclone landfalls in the continental United States, of which six were hurricanes (Hanna, Isaias, Laura, Sally, Delta, Zeta). The entirety of the U.S. Atlantic coast, from Texas to Maine, was under a watch or warning related to tropical cyclones at some point during the season. The most significant tropical cyclone was Hurricane Laura. That storm struck southwestern Louisiana in late August, and tied the state record for the strongest landfalling hurricane at 150 mph (240 kph). Total economic damage was minimally estimated at USD18 billion. Damage from Laura was compounded when Hurricane Delta made landfall in early October approximately 13 miles (21 kilometers) east of where Laura came ashore. Tropical activity earlier in the Atlantic season targeted the Eastern Seaboard, with three landfalling named storms (Bertha, Fay, and Isaias). Isaias caused damaging impacts along the East Coast, generating a direct economic toll approaching USD5 billion.

Severe Convective Storm (SCS) was the costliest peril of 2020 for the United States. Fourteen events crossed the billion-dollar total loss threshold, of which twelve resulted in at least a billion-dollar payout for public and private insurers. Losses were led by the historic Midwest Derecho in August, generating damage topping USD11 billion, of which USD7 billion was insured. The derecho produced straight-line wind gusts reaching 140 mph (220 kph), and led to devastating structural and agricultural impacts across large portions of the Midwest, particularity Iowa (Cedar Rapids) and Illinois. At least 14 million acres (5.6 million hectares) of cropland was affected in Iowa alone.

The U.S. unofficially recorded 1,248 tornadoes in 2020, which is close to the long-term average. Tornado activity waned after a succession of damaging events early in the season, including the Tennessee Tornado Outbreak in early March, and the Easter Tornado Outbreak in April. The Easter Tornado Outbreak of April 12-14, produced no less than 140 confirmed tornadoes – including three EF4s.

The primary driver of thunderstorm-related costs was again tied to hail. Major hail impacts were cited in parts of Texas, Colorado, Wisconsin, Illinois, Missouri, and South Dakota. A notable damaging hail event affected the San Antonio (Texas) metro region in late May. On May 22, a hailstone measuring 5.33 inches (13.54 centimeters) fell in Texas. Rapidly expanding urban centers in some of the most hail-prone areas in the U.S. – including Texas and Colorado – have resulted in continually rising thunderstorm-related damage costs in recent years.

A destructive wildfire season resulted in a modern record of 10.27 million acres (4.16 million hectares) burned across the U.S. in 2020. This marked the highest acres burned total since current data collection methods began in 1983. Wildfires resulted in direct economic costs topping USD18 billion, of which USD12 billion was insured. The fires were enhanced by prolonged periods of abnormally hot and dry conditions. 2020 was the third costliest year on record for insurers with the peril, following historic seasons in 2017 and 2018. Two states recorded their largest wildfire in modern history, California (August Complex) and Colorado (Cameron Peak Fire). In California, Cal-Fire indicated 33 wildfire related fatalities, while nearly 4.2 million acres (1.7 million hectares) were burned, the most since reliable state records began in 1932. Preliminary data indicated that at least 18,133 structures were destroyed nationwide (most in the West), led by California (10,488), and Oregon (4,026).

In addition to the wildfires, prolonged and severe drought persisted across vast regions of the western U.S. in 2020. Drought conditions remarkably continued to expand through December. According to data from the U.S. Drought Monitor, 49 percent of the country was experiencing drought conditions by mid-December. In addition, 22 percent of the Lower 48 was impacted by extreme or exceptional drought – affecting roughly 24 million people. This marked the most severe U.S. drought since 2012. On August 16, a temperature of 129.9°F (54.4°C) was recorded in Death Valley (California) - unofficially the hottest global temperature ever reliably measured by instrumentation.

Best Practices for a Bespoke View of Risk

The insurance industry largely relies on catastrophe models to provide a robust method of risk accumulation to quantify extreme, yet plausible loss potential from catastrophic events. Outputs from catastrophe models, such as tail probable maximum loss indications and average annual loss are relied upon by insurers for rate indications, capital management, and risk transfer decisions. However, considerable uncertainty is inherent in models that is not always well understood by the stakeholders who rely on modeled loss estimates to make business decisions.

To fully capitalize on the many benefits of catastrophe models, it is essential that insurers take ownership in understanding the inherent assumptions in each model and how they interact with each insurer's unique exposure profile. Since there is incomplete data, engineering and scientific judgement are often used to define event parameters such as hazard, frequency, severity and the vulnerability of exposure. Differences in model methodologies and the resulting loss estimates across vendors demonstrate the uncertainty and range of reasonable outcomes. Through the process of developing a bespoke view of risk, insurers reduce their dependence on model vendors to measure their catastrophe risk and gain greater confidence in their risk tolerance thresholds. A bespoke view of risk that is explainable and defensible can be used to manage portfolios and transfer risk.

Catastrophe models are an important base-line; when customizing a view of risk, it is beneficial to benchmark catastrophe models against each other and secondary data sources. Secondary data sources can include claims data, loss history, scientific publications, and university research – however these can be time consuming and challenging to discern as a technical understanding of each topic is needed.

Insurers can begin to customize their View of Risk through Aon's framework of evaluation, customization, education and integration to enhance insights and internal operations while becoming better prepared to support policyholders during challenging times.

Evaluate

Evaluate model options and identify strengths and concerns

Customize

Customize the view of the risk to account for non-modeled losses and experience

Educate

Educate internal stakeholders, regulators, and reinsurers

Integrate

Integrate view of risk into any value added solutions

***Sara Rausch**, Senior Managing Director, and **Katie Carter**, Managing Director, in Aon's Catastrophe Management team*

Americas (Non-U.S.)

Exhibit 44: Top 5 Most Significant Events in the Americas (Non-U.S.)

Timeframe	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
November 2-13	Hurricane Eta	Central America	300	6.8 billion	93 million
January-December	Drought	Brazil	N/A	3.0 billion	75 million
January 7	Earthquake(s)	Puerto Rico	1	1.5 billion	425 million
June 13-14	Calgary Hailstorm	Canada	0	1.4 billion	1.1 billion
November 16-19	Hurricane Iota	Caribbean	102	1.3 billion	50 million
		All Other Events	~349	6 billion	1.5 billion
		Totals	**~750**	**20 billion[1]**	**3.2 billion[1,2]**

[1] Subject to change as loss estimates are further developed

[2] Includes losses sustained by private insurers and government-sponsored programs

20 bn

Total Economic Losses (USD)
22% below average since 2000

3 bn

Total Insured Losses (USD)
40% below average since 2000

8%
Portion of Global Economic Losses

3%
Portion of Global Insured Losses

16%
Portion of losses covered by insurance

Calgary Hailstorm: June 13
Costliest Canadian hailstorm
Insured Loss: USD1.1 billion

Hurricanes Eta & Iota
Dueling Category 4 hurricane landfalls in Nicaragua; worst Central America natural disasters since 1998
Combined economic toll tops USD8.0 billion

Puerto Rico Earthquakes
Earthquake swarm from Dec '19 to Jan '20
Main event of 2020: M6.4 on January 7
Overall Economic Loss: USD1.5 billion

Amazon Wildfires
Record heat & illegal burning heightens fire spread; Parts of the Pantanal & Gran Chaco Forest among the hardest-hit

11M Acres
Size of Brazil's Pantanal region burned in 2020; 30 percent of the biome

160 mph / 260 kph
Maximum sustained winds of November's Hurricane Iota; Latest calendar Category 5 to form in the Atlantic Basin

25 km / 15 mi
Estimated length of an ice jam along the Athabasca River; led to major flooding in Fort McMurray, Canada

Economic and insured losses from natural catastrophes in the Americas were comparable to those in 2019, but substantially less than the record year in 2017. The overall economic total was listed at roughly USD20 billion. For comparison, the economic cost of the 2017 events was nearly USD150 billion. Of the USD20 billion economic toll in 2020, just USD3.2 billion was covered by public and private insurance entities – which highlights the importance of continuing to narrow the protection gap in this region. Based on annual data from 2000-2019, economic losses in 2020 were 22 percent lower than average (USD26 billion), but 22 percent higher compared to the 21st Century median (USD17 billion). Insured losses were 40 percent below the average (USD5.3 billion), but 20 percent higher than the median (USD2.7 billion).

The most newsworthy and impactful events across the Americas (Non-U.S.) in 2020 were hurricane Eta and Iota's devastation across Central America in November. The pair of Category 4 storms concluded the Atlantic season with landfalls along the northern Nicaraguan coast less than two weeks apart. Hurricane Eta generated more than USD6.8 billion in damage across Central America, a majority of which was incurred in Honduras and Guatemala and went uninsured. Hurricane Iota, the only cyclone of the season to briefly reach category 5 intensity, weakened slightly prior to landfall. Iota generated an additional USD1.3 billion in total losses for the region. The compounding impacts of these hurricanes led to a considerable loss of life and an ongoing humanitarian crisis for large expanses of Central America. Prior to reaching Nicaragua, Iota produced extensive damage across the Colombian Islands of San Andrés and Providencia. In Providencia alone, an estimated 98 percent of the island's infrastructure was impacted.

In Mexico, tropical cyclones crossed the Yucatan Peninsula late in the season, with three named storms making landfall in the state of Quintana Roo in October (Gamma, Delta, Zeta). The storms generated notable damage (though less than feared), and further hampered the tourism industry, which was already affected by the COVID-19 pandemic.

Canada endured an active year with total losses from natural catastrophes totaling USD3.9 billion, of which USD2.1 billion was insured. Losses were led by the historic hailstorm in the Calgary (Alberta) metro region on June 13. The storm became a billion-dollar insurance event, ranking as the costliest SCS event on record for the local industry. It was also the fifth-costliest insured loss event regardless of peril for Canada. In late April, a significant ice-jam along portions of the Athabasca and Clearwater Rivers in northern Alberta led to extensive flooding and evacuations in Fort McMurray. This event incurred hundreds of millions (USD) in insured losses. Fort McMurray was previously heavily affected by a large wildfire in May 2016.

Elsewhere, a strong magnitude-7.4 (M7.4) earthquake struck offshore the state of Oaxaca in Mexico in June, causing multiple casualties and localized damage. Earlier in 2020, an earthquake swarm generated a billion-dollar damage bill in Puerto Rico. The strongest quake of the sequence was a M6.4 on January 7. A notable aftershock, registering as a M5.4, struck on May 2 and resulted in additional local damage.

In South America, record summertime heat aided in increased wildfire activity. The fires were particularly severe in the Gran Chaco Forest and Pantanal regions of Argentina, Brazil, Bolivia, and Paraguay. A national emergency was declared in Paraguay because of the fires. Wildfire ignition in these regions is typically driven largely by human activities, which commonly include deforestation – aimed to increase land availability for livestock and crops. Data from the Laboratory for Environmental Satellite Applications (LASA) in Brazil, indicated wildfires burned at least 30 percent of Brazil's Pantanal biome in 2020. The Pantanal is the largest tropical wetland on the planet and home to numerous rare species, and indigenous peoples. In addition to the fires, severe drought conditions, enhanced by the developing La Niña, continued to plague large areas of South America. Agricultural regions in southern Brazil, Paraguay, and Argentina were among the most impacted. In 2020, the Paraguay River reached its lowest level in at least 50 years, producing significant impacts to the local economy.

EMEA (Europe, Middle East & Africa)

Exhibit 45: Top 5 Most Significant Events in EMEA

Timeframe	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
February 9-10	Windstorm Ciara	Europe	14	2.7 billion	2.1 billion
October 2-4	Storm Alex Floods	France, Italy	16	3.2 billion	307 million
March 22	Zagreb Earthquake	Croatia	2	6.1 billion	79 million
August-September	Flooding	Sudan	120	250 million	Negligible
January 4-9	Flooding	Israel	7	580 million	430 million
		All Other Events	~1,570	15 billion	5.3 billion
		Totals	**~1,730**	**28 billion[1]**	**8.2 billion[1,2]**

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

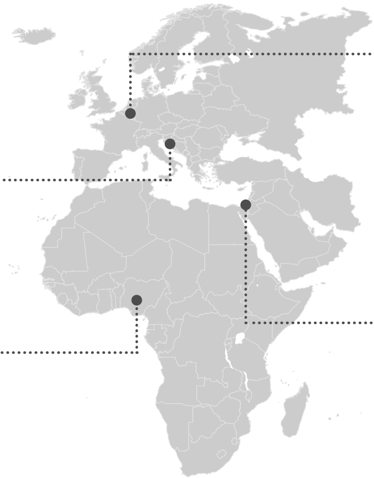
Total Economic Losses (USD)
26% below average since 2000

Total Insured Losses (USD)
22% below average since 2000

10%
Portion of Global Economic Losses

8%
Portion of Global Insured Losses

30%
Portion of losses covered by insurance



Windstorm Ciara
Costliest EU Windstorm since 2010
Insured Loss: USD2.1 billion

Croatia Earthquakes
M5.3 in Zagreb on March 22
M6.4 in Petriinja on December 29

Israel Floods
costliest insurance event on record for the country

Flooding in Africa
more than 1,000 fatalities

+1.6°C / +2.88°F
Temperature anomaly (1981-2010) in Europe, warmest year on record per Copernicus

165 kph / 105 mph
wind speed of Cyclone Gati at Somalia landfall; country's strongest on record

117 killed
number of fatalities related to the deadliest earthquake of 2020 near Izmir, Turkey

Total economic losses caused by natural disasters in Europe, Middle East and Africa (EMEA) in 2020 were significantly lower when compared to the 21st Century average. The aggregate direct economic toll reached USD28 billion, which represented only 74 percent of the average annual loss (2000-2019) and 70 percent of the median. Focusing solely on weather-related disasters, EMEA saw an even more striking reduction against the average (40 percent) and the median (46 percent).

Extraordinarily, the severe convective storm peril, which was responsible for several multi-billion-dollar events in the past, failed to generate a single loss event beyond USD250 million during 2020. Preliminary estimates suggest that SCS losses in Europe were at their lowest since 2016 on an inflation-adjusted basis. However, it is worth noting that a single year of under-average losses does not imply any change in an otherwise increasing trend seen in recent decades.

Relatively low disaster losses in Europe also translated to under-average insurance payouts, which were at their lowest since 2006. At the same time, European insurers registered above-average losses from the Windstorm peril, historically the costliest type of events. Storm Ciara, also known as Sabine or Elsa, left widespread impacts across 20 countries in its wake and more than 1 million insurance claims. With insured losses of USD2.1 billion, it was tied with Windstorm Friederike (2018) as the costliest storm since Xynthia (2010).

The Croatian capital city of Zagreb was struck by the strongest earthquake in years on March 22, in the midst of the first wave of the COVID-19 pandemic. Total economic losses from the tremor rose to multiple billions due to widespread structural damage on housing stock of historical and architectural value. The country endured another strong earthquake on December 29 with the epicenter near the town of Petrinja. It damaged more than 30,000 buildings and put further strain on country's disaster management.

An October earthquake near Izmir in Turkey became the deadliest tremor of 2020 globally with 117 fatalities, and also the costliest seismic disaster for the country since the earthquake in Van in 2011. Public and private insurance entities registered more than 29,000 claims. The region of the Middle East also recorded several notable flooding events; January floods in Israel became the costliest event for local insurers on record, while widespread inundation in multiple Iranian provinces put further strain on the country's disaster management after the record flooding of 2019.

Across Western, Central and Eastern Africa, flooding events resulted in more than 1,000 fatalities throughout 2020. Particularly difficult humanitarian situation was in Sudan, where hundreds of thousands of people were displaced by a prolonged period of flooding. Relief efforts were further hindered by the emergency situation resulting from the global pandemic. Somalia experienced the strongest (and first hurricane-force) tropical cyclone landfall on record when Cyclone Gati came ashore on November 22, after the fastest 12-hour intensification ever recorded in the North Indian Ocean basin.

APAC (Asia & Oceania)

Exhibit 46: Top 5 Most Significant Events in APAC

Timeframe	Event	Location	Deaths	Economic Loss (USD)	Insured Loss (USD)
June-September	Flooding	China	280	35 billion	2.0 billion
May 15-21	Cyclone Amphan	India, Bangladesh	133	15 billion	525 million
July 3-15	Flooding	Japan	82	8.5 billion	2.0 billion
June-September	Flooding	India	1,922	7.5 billion	805 million
September 5-8	Typhoon Haishen	Japan, China, Korean Peninsula	4	4.0 billion	1.6 billion
		All Other Events	~3,100	31 billion	5.0 billion
		Totals	**~5,500**	**101 billion[1]**	**12 billion[1,2]**

[1] *Subject to change as loss estimates are further developed*

[2] *Includes losses sustained by private insurers and government-sponsored programs*

101 bn

Total Economic Losses (USD)
2% above average since 2000

12 bn

Total Insured Losses (USD)
9% below average since 2000

38%
Portion of Global Economic Losses

12%
Portion of Global Insured Losses

12%
Portion of losses covered by insurance

Kyushu Floods
Costliest Japan event
Economic Loss: USD8.5 billion
Insured Loss: USD2.0 billion

India Monsoon Floods
Deadliest event globally
1,922 fatalities

China Monsoon Floods
Highest seasonal rainfall since 1998
Economic Loss: USD35 billion

Australia Hailstorms
Sydney, Brisbane, Melbourne
hit by major hailstorms in 2020
Multi-billion-dollar insurance toll

38°C / 100.4°F
Highest temperature record above the Arctic circle, set on June 20

836
Number of river locations in China above flood stage; 76 of which were historical records

195 mph / 315 kph
Super Typhoon Goni strongest landfalling storm ever recorded globally

An active year for natural disasters left costly and deadly impacts across Asia-Pacific (APAC) in 2020. The total direct economic cost of APAC natural disasters was listed at USD101 billion. This was 2 percent above the 2000-2019 average and 34 percent higher than the median. However, only 12 percent (or USD12 billion) of the economic cost was covered by insurance. It was 9 percent lower than the 21st Century average, but 88 percent higher than the median. APAC remains a region where the protection gap continues to be a concern as a high portion of disaster costs remain uninsured.

The Asian continent was heavily affected by one of the most prolific monsoon seasons in decades. Enhanced rainfall from a transition to La Niña conditions aided in hundreds of major rivers breaching flood stage. The worst impacts were felt in China, where the seasonal Mei-yu front brought the most rainfall since 1998. More than 1.4 million homes were damaged, and vast swaths of agriculture submerged. The total economic cost in China alone was USD35 billion. Similar flooding was recorded in nearby Japan, where one stretch from July 3-15 on Kyushu Island prompted several prefectural and national rainfall records. Total damage from that event alone topped USD8.5 billion; of which USD2.0 billion was insured. Further flooding on the Korean Peninsula occurred following one of the region's wettest and longest monsoon seasons in recent memory. Multiple typhoon landfalls (Bavi, Maysak, and Haishen) only made flood conditions worse in South Korea.

Summer monsoon flooding was also seen on the Indian subcontinent. Heavy rains coupled with convective storms from June to September triggered severe flash flooding in central and northern India, resulting in a total financial cost of USD7.5 billion. It also resulted in more than 1,900 fatalities; making it 2020's deadliest global event. Even more flooding occurred in India's southwestern states in October after multiple tropical lows came ashore. The combined damage toll added another USD4 billion. Neighboring countries of Pakistan, Nepal, and Bangladesh were also impacted by exceedingly active flooding season and the combined economic toll reached into the billions (USD).

Tropical cyclone activity in Asia, while well below climatological levels in 2020, still resulted in significant and disastrous impacts. Most notable was Super Typhoon Goni's record-setting Category 5 landfall in the Philippines. The 195 mph (315 kph) storm was the strongest ever recorded globally. Other strong typhoon striking the Philippines included Vamco and Molave. The country cited hundreds of thousands of homes and other properties being damaged or destroyed, and a combined economic toll topping USD2 billion. Several of the same tropical cyclones also struck Vietnam. In October alone, storms Lifa, Nangka, Saudel, and Molave all came ashore in Vietnam and spawned catastrophic flooding in central sections of the country. Government officials cited damage costs of USD1.4 billion in October alone. Remnants from these storms would later traverse neighboring countries of Laos, Cambodia, and Thailand.

Natural peril activity was also elevated in Oceania. Australia was impacted by a series of notable severe thunderstorm events, that were dominated by the hail sub-peril. One stretch on January 19-20 saw the major metro regions of Sydney, Brisbane, Canberra, and Melbourne all be struck by hailstorms that left an insurance bill topping USD1.4 billion from 131,000 claims. Other hailstorms affected Queensland in April and October and resulted in additional insured payouts in the hundreds of millions (USD); while a powerful East Coast Low left widespread wind and flood damage from February 4-11 in Queensland and New South Wales. Also, the historic Australia bushfire season of 2019/20 officially came to an end in May 2020. These fires, covered extensively in the 2019 version of this report, resulted in insured losses topping USD1.6 billion.

The South Pacific Islands dealt with multiple cyclones in both early and late 2020. Cyclone Harold first struck Vanuatu, Fiji, and Tonga in April as a Category 4-equivalent storm, and Cyclone Yasa would later cross Fiji in December as a Category 4-equivalent storm, too. In both instances, there was substantial damage to residential and commercial property. The economic toll from each storm was estimated well into the hundreds of millions (USD), including USD440 million in Vanuatu from Harold.

From a climate perspective, APAC noted several unusual warm temperature records. The most notable occurred in the higher latitudes of Asia. Verkhoyansk in Russian Siberia recorded a temperature of 38.0°C (100.4°F) on June 20. This was the highest temperature ever recorded above the Arctic Circle. The hot temperatures would later fuel wildfires in parts of Russia in 2020.

Appendix A: 2020 Global Disasters

United States

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-12/31	Drought	Nationwide	N/A	N/A	4.5+ billion
01/10-01/12	Severe Weather	Central & Eastern U.S.	12	115,000+	1.3+ billion
02/03-02/08	Severe Weather	Central & Eastern U.S.	5	135,000+	1.5+ billion
02/08-02/10	Severe Weather	West	0	15,000+	140+ million
02/10-02/17	Flooding	Southeast	0	5,000+	175+ million
02/25-02/27	Winter Weather	Midwest, Northeast	1	5,000+	75+ million
03/02-03/05	Severe Weather	Midwest, Southeast	25	55,000+	2.5+ billion
03/12-03/13	Severe Weather	Midwest, Southeast	0	5,000+	75+ million
03/17-03/20	Severe Weather	Plains, Midwest, Southeast, Northeast	0	30,000+	290+ million
03/18	Earthquake	Utah	0	1,000+	80+ million
03/20	Flooding	Midwest	8	30,000+	10+ million
03/24-03/25	Severe Weather	Southeast	0	5,000+	90+ million
03/27-03/30	Severe Weather	Plains, Midwest, Southeast, Northeast	0	165,000+	2.9+ billion
03/31	Severe Weather	Southeast	0	10,000+	125+ million
03/31	Earthquake	Idaho	0	2,000+	20+ million
04/06-04/09	Severe Weather	Midwest, Plains, Southeast, Mid-Atlantic	0	270,000+	3.0+ billion
04/10-04/14	Severe Weather	Midwest, Plains, Southeast, Mid-Atlantic	38	270,000+	3.6+ billion
04/18-04/20	Severe Weather	Midwest, Plains, Southeast	3	70,000+	800+ million
04/21-04/24	Severe Weather	Plains, Southeast, Mid-Atlantic	7	125,000+	1.5+ billion
04/24-04/26	Severe Weather	Central & Eastern U.S.	0	66,000+	860+ million
04/27-04/30	Severe Weather	Midwest, Plains, Southeast	0	112,500+	1.1+ billion
05/02-05/03	Severe Weather	Plains, Midwest, Southeast	2	68,000+	850+ million
05/04-05/05	Severe Weather	Plains, Midwest, Southeast	0	120,000+	1.5+ billion
05/05-05/10	Wildfire	Florida Panhandle Wildfire	0	500+	50+ million
05/07-05/08	Severe Weather	Plains, Southeast	0	17,000+	150+ million
05/12-05/16	Wildfire	Collier County Fire	0	Unknown	20+ million
05/13-05/15	Severe Weather	Plains, Midwest, Northeast	0	55,000+	530+ million
05/15	Earthquake	Nevada	0	1,000+	25+ million
05/16-05/21	SCS & Floods	Plains, Midwest, Southeast	1	110,000+	2.1+ billion
05/20-05/24	Severe Weather	Rockies, Plains, Midwest	2	150,000+	1.8+ billion
05/24-05/27	Tropical Storm Bertha	Southeast, Mid-Atlantic	0	15,000+	200+ million
05/25-05/26	Severe Weather	Plains, Midwest, Southeast	0	15,000+	135+ million
05/27-05/28	Severe Weather	Texas	0	115,000+	1.5+ billion
05/30-05/31	Severe Weather	Northwest	0	Thousands	50+ million
06/02-06/04	Severe Weather	Plains, Midwest, Northeast	3	55,000+	775+ million
06/02-06/10	Tropical Storm Cristobal	Southeast	1	20,000+	325+ million
06/04	Severe Weather	South Dakota	0	27,500+	475+ million
06/05-06/11	Severe Weather	West, Rockies, Plains, Midwest	0	77,500+	790+ million

United States

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
06/19-06/22	Severe Weather	Plains, Midwest, Southeast	0	35,000+	255+ million
06/26-06/27	Severe Weather	Plains, Midwest	0	10,000+	68+ million
07/02-07/10	Severe Weather	Rockies, Plains, Midwest	1	Thousands	150+ million
07/05-07/07	Severe Weather	Mid-Atlantic	1	17,500+	215+ million
07/10-07/12	Tropical Storm Fay	Northeast, Mid-Atlantic	6	15,000+	350+ million
07/10-07/12	Severe Weather	Rockies, Plains, Southeast, Midwest	0	100,000+	1.3+ billion
07/17-07/19	Severe Weather	Plains, Midwest, Northeast	0	14,000+	150+ million
07/20-07/23	Severe Weather	Plains, Midwest, Mid-Atlantic	0	7,500+	100+ million
07/25-07/27	Hurricane Hanna	Texas	0	45,000+	1.0+ billion
07/30-08/05	Hurricane Isaias	Southeast, Mid-Atlantic, Northeast	15	340,000+	4.8+ billion
08/05	Severe Weather	Colorado	0	22,000+	260+ million
08/08-08/12	Severe Weather	Rockies, Plains, Midwest, Mid-Atlantic	4	540,000+	12.6+ billion
08/09	Earthquake	North Carolina	0	2,500+	25+ million
08/13-08/17	Severe Weather	Plains, Midwest	0	40,000+	440+ million
08/13-10/29	Cameron Peak Fire	Colorado	0	1,350+	275+ million
08/16-10/05	Beachie Creek Fire	Oregon	4	12,000+	1.7+ billion
08/16-09/16	SCU Complex Fire	California	0	1,800+	190+ million
08/17-09/16	LNU Complex Fire	California	5	12,000+	3.0+ billion
08/17-09/22	CZU Complex Fire	California	1	12,000+	3.5+ billion
08/18-09/04	Carmel Fire	California	0	1,500+	270+ million
08/18-10/05	North Complex Fire	California	15	6,500+	1.3+ billion
08/18	Severe Weather	Florida	0	2,000+	50+ million
08/21-08/25	Hurricane Marco	Florida, Southeast	0	2,000+	10+ million
08/21-08/29	Hurricane Laura	Plains, Southeast, Mid-Atlantic	33	400,000+	18.0+ billion
08/26-08/28	Severe Weather	Plains, Mid-Atlantic, Northeast	0	25,000+	205+ million
08/29-08/30	Severe Weather	Plains	0	10,000+	110+ million
09/04-10/05	Creek Fire	California	0	3,000+	550+ million
09/05-09/06	Severe Weather	Midwest	0	14,000+	165+ million
09/06-09/18	Babb Fire	Washington	0	2,300+	175+ million
09/06-10/06	Bobcat Fire	California	0	3,600+	190+ million
09/07-09/09	Severe Weather	West	1	35,000+	375+ million
09/07-10/03	Holiday Farm Fire	Oregon	1	5,750+	675+ million
09/07-09/16	Almeda Drive Fire	Oregon	3	5,500+	775+ million
09/08-09/23	Echo Mountain Fire	Oregon	0	1,500+	175+ million
09/08-10/03	Riverside Fire	Oregon	0	4,250+	275+ million
09/08-10/05	Slater Fire	California, Oregon	2	1,000+	150+ million
09/10-09/10	Flooding	Mid-Atlantic	0	2,000+	40+ million
09/14-09/18	Hurricane Sally	Southeast	8	230,000+	7.0+ billion

United States

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
09/20-09/23	Tropical Storm Beta	Plains, Southeast	1	20,000+	400+ million
09/27-10/05	Glass Fire	California	0	8,000+	3.8+ billion
10/07-10/08	Severe Weather	Northeast	0	23,000+	235+ million
10/07-10/11	Hurricane Delta	Plains, Southeast	4	150,000+	3.0+ billion
10/14-10/29	East Troublesome Fire	Colorado	2	2,000+	650+ million
10/17-10/29	Calwood Fire	Colorado	0	1,250+	25+ million
10/24-10/30	Hurricane Zeta	Southeast	6	200,000+	3.5+ billion
10/25-10/28	Winter Weather	West, Plains	0	39,000+	475+ million
11/08-11/12	Hurricane Eta	Southeast	11	45,000+	1.5+ billion
11/10-11/12	Severe Weather	Midwest, Mid-Atlantic	11	25,000+	350+ million
11/15-11/16	Severe Weather	Midwest, Mid-Atlantic, Northeast	1	55,000+	575+ million
11/24-11/25	Severe Weather	Plains	0	5,000+	50+ million
11/29-12/01	Severe Weather	Southeast, Mid-Atlantic, Northeast	0	10,000+	110+ million
12/01-12/03	Flooding	Alaska	0	Hundreds	50+ million
12/04-12/06	Winter Weather	Mid-Atlantic, Northeast	0	5,000+	25+ million
12/16-12/17	Winter Weather	Mid-Atlantic, Northeast	2	10,000+	75+ million
12/16-12/16	Severe Weather	Southeast	0	7,500+	50+ million
12/22-12/25	Severe Weather	Central and Eastern U.S.	5	30,000+	340+ million
12/30-01/01	Severe Weather	Plains, Southeast, Midwest, Northeast	0	5,000+	35+ million

Remainder of North America (Non-U.S.)

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/07-01/11	Earthquake	Puerto Rico	1	20,000+	1.5+ billion
01/11-01/12	Flooding	Canada	0	6,200+	180+ million
01/14-01/18	Winter Weather	Canada	0	2,000+	35+ million
01/14-01/20	Winter Weather	Canada	0	2,500+	35+ million
01/17-01/18	Winter Weather	Canada	0	1,750+	60+ million
01/28	Earthquake	Cayman Islands, Jamaica, Cuba	0	2,250+	Millions
01/31-02/01	Flooding	Canada	0	2,000+	95+ million
02/06-02/08	Winter Weather	Canada	0	2,000+	35+ million
02/26-02/28	Winter Weather	Canada	1	2,500+	35+ million
02/28-02/29	Severe Weather	Honduras	3	3,500+	Millions
04/13	Flooding	Canada	0	1,500+	25+ million
04/23-05/03	Flooding	Canada	0	1,500+	35+ million
04/26-04/30	Flooding	Canada	1	4,000+	1.3+ billion
05/02	Earthquake	Puerto Rico	0	3,000+	150+ million
05/31	Tropical Storm Amanda	El Salvador, Guatemala, Honduras	33	3,400+	200+ million
06/02-06/08	Tropical Storm Cristobal	Mexico, Guatemala, El Salvador	1	10,000+	660+ million

Remainder of North America (Non-U.S.)

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
06/13-06/14	Severe Weather	Canada	0	65,000+	1.4+ billion
06/23	Earthquake	Mexico	10	8,100+	75+ million
06/28-06/29	Severe Weather	Canada	0	2,000+	55+ million
07/08	Severe Weather	Canada	0	2,000+	50+ million
07/12	Severe Weather	Canada	0	Thousands	25+ million
07/16	Severe Weather	Canada	0	1,000+	25+ million
07/19	Severe Weather	Canada	0	1,000+	30+ million
07/22-07/24	Severe Weather	Canada	0	13,100+	150+ million
07/25-07/27	Hurricane Hanna	Mexico	5	10,000+	135+ million
07/30-08/05	Hurricane Isaias	Caribbean, Canada	3	7,000+	225+ million
08/02-08/03	Severe Weather	Canada	0	5,000+	57+ million
08/19-08/20	Hurricane Genevieve	Mexico	2	2,000+	50+ million
08/21-08/25	Hurricane Marco	Mexico, Costa Rica	1	Thousands	40+ million
08/21-08/29	Hurricane Laura	Caribbean	35	13,000+	170+ million
09/02-09/04	Hurricane Nana	Central America	0	5,500+	20+ million
09/14-09/16	Hurricane Paulette	Bermuda	0	10,000+	50+ million
09/18-09/19	Tropical Storm Alpha	Portugal	1	2,500+	25+ million
09/23-09/24	Hurricane Teddy	Canada	0	2,500+	35+ million
10/02-10/06	Tropical Storm Gamma	Mexico	7	25,000+	100+ million
10/07-10/11	Hurricane Delta	Mexico	2	15,000+	350+ million
10/10	Severe Weather	Canada	0	8,000+	45+ million
10/24-10/30	Hurricane Zeta	Jamaica, Mexico	2	Thousands	60+ million
10/29	Flooding	El Salvador	10	125+	Unknown
11/03-11/07	Hurricane Eta	Central America	309	135,000+	6.8+ billion
11/14-11/19	Hurricane Iota	Central America	102	110,000+	1.3+ billion
11/15-11/16	Severe Weather	Canada	0	8,250+	75+ million

South America

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-12/31	Drought	Brazil	N/A	N/A	3.0+ billion
01/01-12/31	Drought	Paraguay	N/A	N/A	250+ million
01/01-12/31	Drought	Argentina	N/A	N/A	700+ million
01/17-01/29	Flooding	Brazil	70	2,000+	300+ million
02/08-02/29	Flooding	Bolivia	17	10,000+	10s of millions
02/09-02/10	Flooding	Brazil	4	4,000+	50+ million
02/11-02/19	Flooding	Argentina	1	1,000+	10s of millions
02/17-02/25	Flooding	Peru	15	2,400+	10s of millions
02/25-02/27	Flooding	Colombia	8	750+	Millions
03/01-03/03	Flooding	Brazil	60	2,000+	75+ million
06/30	Severe Weather	Brazil	10	12,500+	100+ million
07/01-07/15	Flooding	Brazil	0	4,500+	10s of millions
07/01-07/15	Flooding	Colombia	11	3,500+	10s of millions
08/01-10/31	Wildfire	Argentina, Bolivia, Brazil, Paraguay	N/A	Unknown	100s of millions
08/14-08/15	Severe Weather	Brazil	1	5,000+	50+ million
10/31-11/02	Flooding	Colombia	0	8,820+	25+ million
11/08-11/17	Flooding	Venezuela	6	7,500+	30+ million
11/14-11/19	Hurricane Iota	Colombia	7	30,000+	100+ million
12/17	Flooding	Brazil	12	Thousands	75+ million

Europe

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/13-01/15	Windstorm Brendan	Ireland, United Kingdom	1	Thousands	57+ million
01/19-01/23	Flooding	Spain	14	11,600+	315+ million
01/28-01/28	Windstorm Lolita	Central Europe	0	20,500+	40+ million
02/03-02/04	Windstorm Petra	Central Europe	3	81,500+	185+ million
02/09-02/10	Windstorm Ciara	Western & Central Europe	14	1.1+ million	2.7+ billion
02/15-02/16	Windstorm Dennis	Western & Northern Europe	6	131,500+	915+ million
02/22-02/25	Severe Weather	Spain	0	17,000+	15+ million
02/23-02/24	Windstorm Yulia	Central Europe	0	Thousands	273+ million
02/27	Windstorm Bianca	Western & Central Europe	0	Thousands	161+ million
02/29	Windstorm Jorge	Western Europe	0	Thousands	150+ million
03/01	Windstorm Leon	France	0	5,000+	Millions
03/02	Windstorm Karine	France, Spain	0	20,000+	40+ million
03/03	Windstorm Myriam	France, Spain	0	20,000+	40+ million
03/12-03/13	Windstorm Laura	Denmark, Sweden, Germany, Poland	0	Thousands	150+ million
03/22	Earthquake	Croatia	2	25,000+	6.1+ billion
03/24-04/02	Winter Weather	Central & Southern Europe	0	N/A	513+ million

Europe

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
04/01	Flooding	Spain	0	2,000+	15+ million
04/04-04/06	Flooding	Greece	0	2,500+	Millions
04/04-04/15	Wildfire	Ukraine	0	Unknown	280+ million
04/15	Winter Weather	Austria	0	N/A	38+ million
04/17	Severe Weather	France	0	3,000+	Millions
05/09-05/11	Severe Weather	Western & Central Europe	0	2,500+	157+ million
05/23	Severe Weather	Central Europe	0	15,000+	10s of Millions
05/29-05/30	Severe Weather	Ukraine & Belarus	0	Hundreds	40+ million
06/07-06/08	Flooding	Central Europe	2	11,750+	50+ million
06/10-06/26	Flooding	Romania	3	3,100+	85+ million
06/13-06/15	Severe Weather	Central Europe	1	30,000+	200+ million
06/21-06/23	Flooding	Ukraine, Central Europe	4	22,000+	480+ million
06/22-06/23	Flooding	Serbia, Bosnia & Herzegovina	0	1,800+	43+ million
06/26-06/29	Flooding	Central Europe	0	13,000+	205+ million
06/30	Severe Weather	Finland	0	5,000+	10s of millions
07/06-07/09	Wildfire	Ukraine	5	100+	162+ million
07/14	Severe Weather	Spain	0	Thousands	35+ million
07/14-07/15	Severe Weather	Russia	0	1,500+	Millions
07/22-07/24	Severe Weather	Southern Europe	0	Thousands	65+ million
07/28-07/29	Severe Weather	Central Europe	0	Thousands	230+ million
08/03-08/06	Severe Weather	Central Europe	0	Thousands	207+ million
08/08-08/09	Flooding	Greece	8	3,000+	30+ million
08/09-08/14	Severe Weather	Central Europe	0	Hundreds	190+ million
08/11	Severe Weather	Spain	0	9,000+	35+ million
08/16-08/18	Severe Weather	Central Europe	0	Thousands	135+ million
08/19-08/20	Windstorm Ellen	Ireland, United Kingdom	0	7,000+	20+ million
08/22-08/23	Severe Weather	Italy, Austria	0	Hundreds	35+ million
08/25-08/26	Windstorm Francis	Western & Central Europe	0	Hundreds	135+ million
08/29-08/30	Severe Weather	Italy, Central Europe	4	Thousands	80+ million
09/05-09/06	Severe Weather	Central Europe	0	20,000+	20+ million
09/17-09/20	Storm Ianos	Greece	4	Thousands	240+ million
09/17	Windstorm Aila	Finland, Estonia	0	Hundreds	45+ million
09/19	Flooding	France	0	1,000+	53+ million
09/25-09/27	Severe Weather	Italy	0	Thousands	60+ million
09/26-09/27	Windstorm Odette	Belgium	0	13,000+	35+ million
10/01-10/02	Windstorm Alex	France	0	39,000+	125+ million
10/02-10/04	Flooding	France, Italy	16	Thousands	3.2+ billion
10/03-10/05	Severe Weather	Poland, Czech Republic, Austria	2	1,500+	15+ million

Europe

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
10/12-10/14	Flooding	Central Europe	1	4,100+	25+ million
10/19-10/21	Windstorm Barbara	France, Spain, Portugal	1	Thousands	70+ million
10/31-11/01	Windstorm Aiden	Ireland, United Kingdom	0	10,000+	25+ million
11/05-11/06	Flooding	Spain	0	12,000+	230+ million
11/18-11/19	Windstorm Liisa	Finland, Sweden	0	5,500+	25+ million
11/21-11/22	Flooding	Italy	0	Hundreds	10s of millions
11/26-11/27	Severe Weather	Spain	0	Hundreds	50+ million
11/27-11/28	Flooding	Italy	3	Hundreds	60+ million
12/04-12/06	Winter Weather	Southern & Central Europe	0	Thousands	678+ million
12/25	Flooding	Portugal	0	Hundreds	36+ million
12/26-12/28	Windstorm Bella	Western Europe	0	100,000+	419+ million
12/29	Earthquake	Croatia, Balkans	7	9,000+	1.2+ billion
12/30	Other	Norway	10	Dozens	130+ million

Middle East

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/04-01/09	Flooding	Israel	7	50,000+	580+ million
01/09-01/20	Flooding	Iran	4	20,000+	808+ million*
01/09-01/12	Flooding	United Arab Emirates	1	Thousands	75+ million
01/24	Earthquake	Turkey	41	23,000+	88+ million
02/04-02/05	Winter Weather	Turkey	41	Unknown	Negligible
02/23	Earthquake	Turkey, Iran	14	6,000+	Millions
02/24-04/30	Flooding	Iran	23	25,000+	1.5+ billion*
03/12-03/13	Flooding	Egypt	40	1,000+	76+ million
03/18	Flooding	Iraq	8	3,500+	100+ million
03/25	Flooding	Yemen	2	5,000+	10+ million
04/15-04/30	Flooding	Yemen	14	2,000+	10+ million
05/27-05/31	Flooding	Oman	3	Hundreds	Millions
06/03-06/04	Flooding	Yemen	16	Hundreds	Negligible
06/14	Earthquake	Turkey	1	2,500+	Negligible
06/21-06/23	Flooding	Turkey	7	5,000+	35+ million
07/12-07/14	Flooding	Turkey	6	Hundreds	Millions
07/22-07/25	Flooding	Yemen	17	500+	Unknown
08/02-08/07	Flooding	Yemen	174	9,000+	Millions
08/22-08/23	Flooding	Turkey	16	1,000+	250+ million
09/29	Severe Weather	Turkey	0	Thousands	Millions
10/09-10/15	Wildfire	Syria	3	1000+	Millions
10/19	Severe Weather	Turkey	1	3,000+	130+ million

Middle East

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
10/30	Earthquake	Turkey	115	29,000+	450+ million
11/24-12/07	Flooding	Iran	7	Unknown	50+ million
12/25-12/25	Winter Weather	Iran	12	N/A	Negligible

**Free market conversion rate*

Africa

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-01/31	Flooding	Madagascar, Mozambique	60	25,800+	10s of millions
01/28-02/03	Flooding	Tanzania	40	5,000+	Millions
01/28-02/13	Flooding	Burundi	3	5,000+	Millions
01/28-02/03	Flooding	Rwanda	19	Thousands	Millions
03/03-03/05	Flooding	Rwanda	3	1,000+	Millions
03/10-03/17	Flooding	Tanzania	0	3,500+	Unknown
03/13-03/17	Cyclone Herold	Madagascar	1	2,000+	Millions
03/14-03/18	Flooding	Democratic Republic of the Congo	0	10,000+	Millions
03/16-03/22	Severe Weather	Burundi	2	1,000+	Millions
03/17-03/22	Flooding	Zambia	0	2,000+	Unknown
03/24-03/31	Flooding	Kenya	1	2,000+	Unknown
04/13-04/19	Flooding	Burundi	0	6,000+	Millions
04/16-04/17	Flooding	Democratic Republic of the Congo	52	18,500+	Millions
04/17-05/10	Flooding	Rwanda	73	2,500+	Unknown
04/17-05/10	Flooding	Uganda	5	3,000+	Negligible
04/18	Flooding	Angola	24	2,000+	Millions
04/18-06/01	Flooding	Kenya	237	161,000+	10s of millions
04/20-04/21	Flooding	Djibouti	8	15,000+	Millions
04/20-04/28	Flooding	Somalia	13	2,000+	Unknown
04/24-05/09	Flooding	Ethiopia	12	10,000+	Millions
05/28	Flooding	Ethiopia	10	Unknown	Negligible
06/15-08/15	Flooding	Somalia	4	10,000+	Millions
06/18	Flooding	Ivory Coast	17	500+	Unknown
06/24-10/31	Flooding	Nigeria	155	75,000+	100+ million
07/01-09/10	Flooding	Niger	65	32,000+	10s of millions
07/01-08/31	Flooding	South Sudan	NA	Thousands	Millions
07/20-09/30	Flooding	Ethiopia	NA	25,000+	Millions
07/31-09/30	Flooding	Sudan	120	172,000+	250+ million
08/01-08/31	Flooding	Mali	0	2,000+	Unknown
08/01-08/31	Flooding	Chad	10	10,000+	Millions

Africa

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
08/01-08/31	Flooding	Kenya	0	1,000+	Unknown
08/25-08/31	Flooding	Uganda	8	Thousands	Unknown
08/25-09/10	Flooding	Burkina Faso	13	Unknown	Millions
09/01-09/15	Flooding	Mauritania	7	2,000+	Unknown
09/01-10/31	Flooding	Togo	11	4,000+	Millions
09/05	Flooding	Senegal	6	2,000+	18+ million
09/06-09/07	Flooding	Guinea	0	2,000+	Millions
10/01-10/03	Flooding	Democratic Republic of the Congo	15	Unknown	Negligible
10/01-10/31	Flooding	Mozambique	22	2,900+	Unknown
10/13-10/15	Flooding	Tanzania	12	Hundreds	Unknown
10/27	Severe Weather	Libya	0	10,000+	Millions
11/17-11/21	Severe Weather	South Africa	10	Hundreds	Millions
11/22-11/23	Cyclone Gati	Somalia	8	4,000+	Millions
12/01-12/04	Flooding	Democratic Republic of the Congo	18	Unknown	Unknown
12/29-12/30	Cyclone Chalane	Mozambique	2	5,000+	Millions

Asia

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/01-12/31	Drought	China	N/A	N/A	2.4+ billion
01/01-12/31	Drought	Vietnam	N/A	N/A	107+ million
01/04-01/07	Winter Weather	China	0	5,000+	125+ million
01/05-01/09	Severe Weather	China	0	2,500+	35+ million
01/11-01/14	Winter Weather	Afghanistan, Pakistan, India	157	Hundreds	10s of millions
01/12-01/16	Volcano	Philippines	1	3,813+	66+ million
01/19	Earthquake	China	1	4,000+	235+ million
01/23-01/28	Flooding	Indonesia	10	14,250+	Millions
01/23-01/26	Winter Weather	China	0	1,000+	239+ million
01/24-01/25	Severe Weather	Vietnam	0	13,750+	Millions
02/08-02/10	Flooding	Indonesia	0	4,000+	Millions
02/12-02/15	Severe Weather	China	1	Hundreds	16+ million
02/13-02/16	Winter Weather	China	0	Hundreds	30+ million
02/16-02/20	Flooding	Indonesia	6	20,000+	10s of millions
02/22-02/25	Flooding	Indonesia	19	35,000+	10s of millions
03/02-03/05	Severe Weather	Vietnam	3	7,200+	Millions
03/04-03/10	Flooding	Indonesia	2	7,500+	Millions
03/04-03/31	Flooding	Pakistan	54	2,000+	Millions
03/13	Flooding	East Timor	3	2,000+	20+ million
03/20-03/21	Flooding	Indonesia	0	10,000+	Millions

Asia

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
03/20-03/25	Severe Weather	Vietnam	1	8,500+	Millions
03/25-03/31	Flooding	Afghanistan	35	3,300+	Millions
03/30	Flooding	China	8	Unknown	Millions
03/30-03/31	Flooding	Indonesia	1	11,900+	Millions
03/31	Wildfire	China	19	N/A	Negligible
04/01	Earthquake	China	1	3,400+	25+ million
04/01-04/30	Flooding	China	0	5,000+	285+ million
04/01-04/30	Severe Weather	China	0	10,000+	250+ million
04/04-04/05	Flooding	Indonesia	5	2,000+	Unknown
04/07-04/08	Severe Weather	Russia	0	2,000+	Millions
04/10-04/12	Severe Weather	Vietnam	0	2,000+	Millions
04/11-04/13	Flooding	Indonesia	0	7,500+	Unknown
04/13-04/14	Severe Weather	China	0	2,000+	15+ million
04/17-04/19	Severe Weather	China	0	7,500+	65+ million
04/19-04/25	Winter Weather	China	0	Unknown	1.2+ billion
04/20-04/28	Flooding	Indonesia	3	2,500+	Millions
04/21-04/22	Severe Weather	China	0	15,000+	72+ million
04/22-04/27	Flooding	Vietnam	3	6,000+	Millions
04/27	Severe Weather	Uzbekistan, Turkmenistan	1	41,000+	Millions
04/29-05/09	Severe Weather	Thailand	2	10,100+	10s of millions
04/30-05/05	Flooding	Indonesia	2	25,000+	Millions
05/02-05/05	Flooding	Afghanistan	4	2,000+	Unknown
05/02-05/05	Flooding	China	0	Unknown	92+ million
05/03-05/05	Winter Weather	China	0	Unknown	125+ million
05/07-05/10	Severe Weather	Vietnam	1	8,720+	Millions
05/10	Severe Weather	India	29	10,000+	10s of millions
05/15-05/19	Severe Weather	Vietnam	3	2,000+	Unknown
05/15-05/21	Cyclone Amphan	India, Bangladesh, Sri Lanka	133	3.0+ million	15+ billion
05/15-05/31	Severe Weather	China	4	Unknown	71+ million
05/15-05/19	Severe Weather	Vietnam	0	2,000+	Millions
05/18	Earthquake	China	4	1,100+	17+ million
05/18-05/25	Flooding	Indonesia	0	4,000+	Millions
05/19-05/22	Flooding	China	7	Unknown	128+ million
05/25-05/26	Severe Weather	Russia	6	2,000+	Millions
05/27-06/02	Flooding	India	31	Thousands	Millions
06/01-09/30	Flooding	Bangladesh	260	1.3+ million	500+ million
06/01-09/30	Flooding	China	280	1.4+ million	35+ billion
06/01-09/30	Flooding	India	1,922	260,000+	7.5+ billion

Asia

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
06/01-09/30	Flooding	Nepal	401	15,000+	10s of Millions
06/03-06/04	Tropical Strom Nisarga	India	6	500,000+	820+ million
06/10-06/15	Tropical Storm Nuri	China, Philippines	1	6,000+	10s of millions
06/11-06/11	Flooding	Indonesia	4	2,500+	Millions
06/24-06/25	Severe Weather	India	127	Thousands	10s of millions
06/26-07/01	Flooding	Malaysia	0	1,000+	Millions
07/01-08/14	Flooding	South Korea	42	14,100+	420+ million
07/01-09/30	Flooding	Pakistan	410	310,000+	1.5+ billion
07/02-07/04	Flooding	Mongolia	8	2,500+	Millions
07/03-07/15	Flooding	Japan	82	32,544+	8.5+ billion
07/09-07/21	Flooding	Indonesia	109	5,000+	10s of millions
07/18-07/21	Flooding	Vietnam	5	3,000+	22+ million
07/19-07/30	Flooding	Myanmar	0	6,500+	Unknown
07/24-07/30	Flooding	Indonesia	0	16,600+	10s of millions
07/31-08/01	Flooding	Afghanistan	14	Hundreds	Negligible
08/01-08/03	Tropical Storm Sinlaku	Vietnam, Thailand	6	12,000+	Millions
08/02-08/04	Typhoon Hagupit	China, Taiwan	6	13,000+	1.5+ billion
08/04-08/10	Flooding	North Korea	22	17,000+	Millions
08/11-08/12	Typhoon Mekkhala	China	0	Thousands	161+ million
08/18	Earthquake	Philippines	1	1,100+	2.5+ million
08/18-08/21	Tropical Strom Higos	China, Vietnam, Thailand	11	4,000+	142+ million
08/21-08/24	Flooding	Vietnam, Thailand	9	5,000+	Millions
08/22-08/27	Typhoon Bavi	North Korea, South Korea, China	0	Hundreds	635+ million
08/24-08/27	Flooding	Afghanistan	190	2,000+	Unknown
09/01-09/22	Flooding	Sri Lanka	6	1,000+	Unknown
09/01-09/04	Typhoon Maysak	Korean Peninsula, China	32	11,200+	1.0+ billion
09/05-09/08	Typhoon Haishen	Japan, Korean Peninsula	4	150,000+	4.0+ billion
09/11-09/13	Flooding	Indonesia	6	4,000+	Negligible
09/18-09/20	Tropical Storm Noul	Vietnam, Laos, Cambodia, Thailand	18	25,000+	73+ million
09/25-09/28	Flooding	Indonesia	11	2,250+	Negligible
10/01-10/20	Flooding	China	0	Unknown	40+ million
10/02-10/25	Flooding	India	152	20,000+	4.0+ billion
10/04-10/25	Flooding	Cambodia	44	162,000+	100+ million
10/04-10/25	Flooding	Laos	4	5,000+	Millions
10/04-10/25	Flooding	Thailand	4	5,000+	Millions
10/04-10-25	Flooding	Vietnam	154	385,000+	850+ million
10/21-10/31	Flooding	Indonesia	15	2,000+	Unknown
10/25-10/29	Typhoon Molave	Philippines, Vietnam	112	308,000+	640+ million

Asia

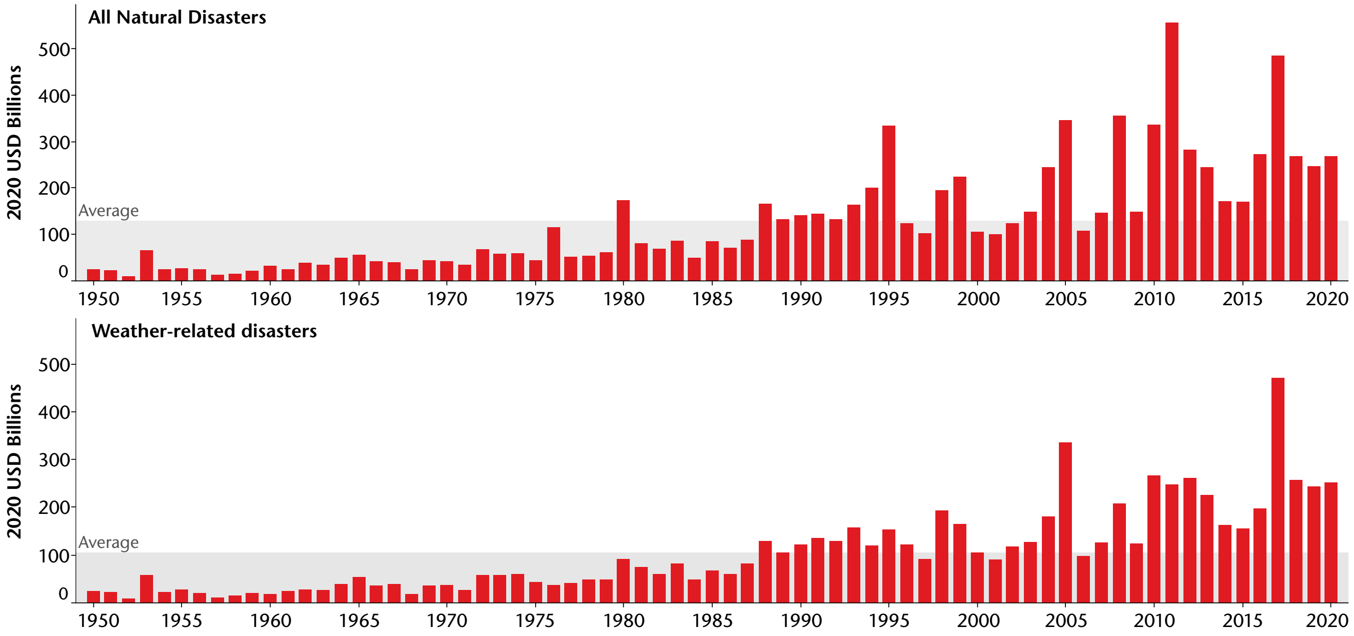
Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
11/01-11/08	Flooding	Indonesia	0	8,000+	Unknown
11/01-11/07	Typhoon Goni	Philippines, Vietnam	31	252,500+	1.0+ billion
11/10-11/11	Tropical Storm Etau	Philippines, Vietnam	2	29,000+	10s of millions
11/11-11/16	Typhoon Vamco	Philippines, Vietnam	102	200,000+	1.0+ billion
11/17-11/19	Winter Weather	China, Russia	N/A	Hundreds	120+ million
11/23-12/02	Flooding	Indonesia	0	9,000+	Millions
11/25-11/26	Cyclone Nivar	India	14	5,000+	600+ million
11/25-12/08	Flooding	Thailand	29	555,000+	10s of millions
12/01-12/10	Flooding	Indonesia	5	20,000+	10s of millions
12/02-12/03	Tropical Strom Burevi	Sri Lanka	3	4,000+	Unknown
12/12-12/17	Flooding	Indonesia	0	2,100+	Unknown
12/16-12/18	Winter Weather	Japan	0	2,000+	200+ million
12/18-12/20	Tropical Cyclone	Philippines	10	1,500+	Millions
12/18-12/24	Flooding	Thailand	1	10,000+	Millions

Oceania (Australia, New Zealand, South Pacific Islands)

Date	Event	Location	Deaths	Structures/Claims	Economic Loss (USD)
01/17-01/19	Cyclone Tino	Tonga, Tuvalu, Fiji	0	Hundreds	10s of millions
01/19-01/20	Severe Weather	Australia	0	129,201+	1.8+ billion
02/01-02/08	Flooding	New Zealand	0	1,100+	29+ million
02/04-02/11	Severe Weather	Australia	0	101,701+	1.2+ billion
02/25	Severe Weather	Australia	0	2,000+	Millions
03/21-03/21	Flooding	Papua New Guinea	12	1,000+	Negligible
04/01-04/07	Flooding	Papua New Guinea	0	2,000+	Millions
04/05-04/09	Cyclone Harold	Solomon Islands, Vanuatu, Fiji, Tonga	30	11,200+	600+ million
04/10	Flooding	Papua New Guinea	10	Hundreds	Negligible
04/19	Severe Weather	Australia	0	25,000+	600+ million
5/25	Severe Weather	Australia	0	5,000+	10s of millions
06/26-06/27	Severe Weather	New Zealand	0	1,550+	Millions
07/17-07/20	Flooding	New Zealand	0	3,500+	10s of millions
08/05-08/08	Severe Weather	Australia	0	2,000+	10s of millions
10/04-10/10	Wildfire	New Zealand	0	Dozens	10s of millions
10/31	Severe Weather	Australia	0	27,500+	1.2+ billion
11/09-11/10	Flooding	New Zealand	0	2,750+	71+ million
12/16-12/17	Cyclone Yasa	Fiji	4	7,500+	100+ million
12/29-12/20	Flooding	Papua New Guinea	15	Dozens	Unknown

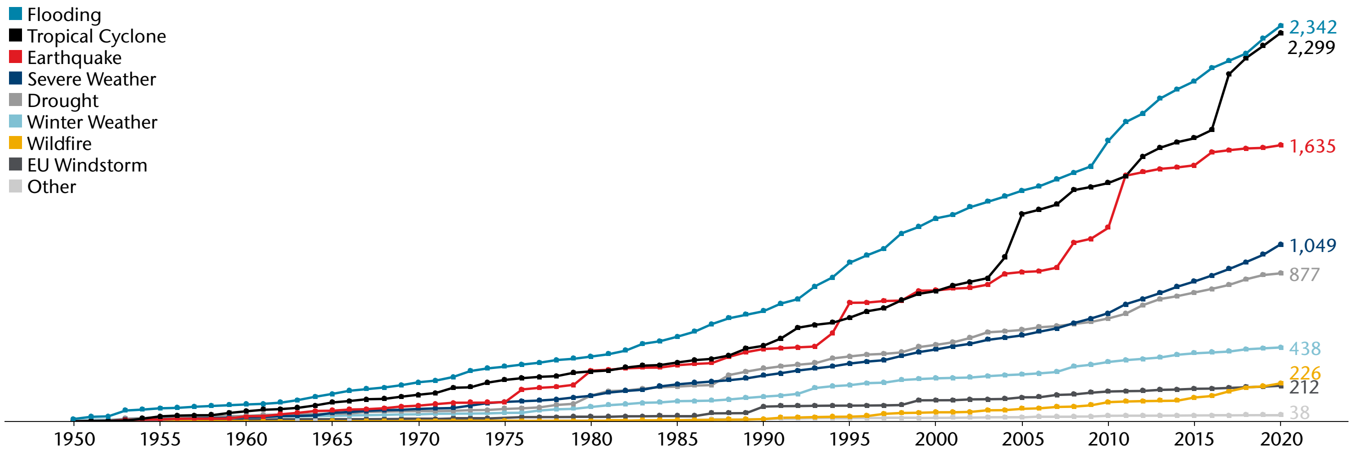
Appendix B: Long-term Natural Disaster Trends

Exhibit 47: Global Economic Losses from natural disasters since 1950



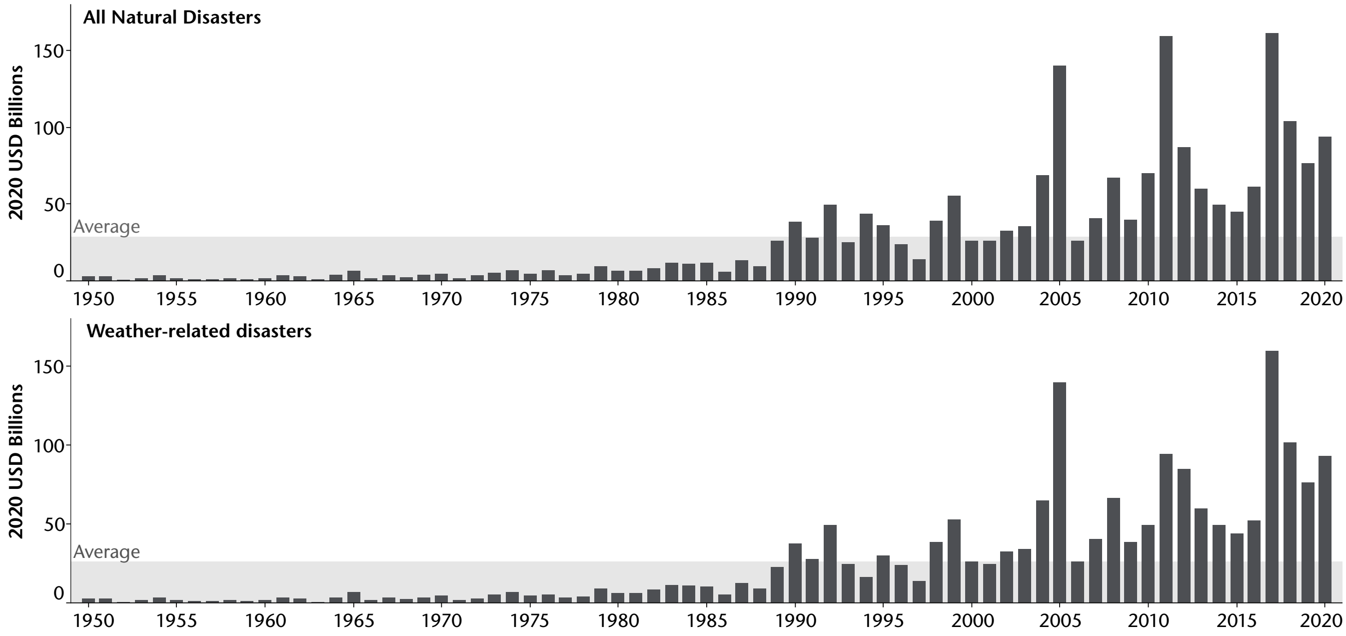
Data: Aon (Catastrophe Insight)

Exhibit 48: Cumulative Global Economic Losses by peril since 1950 (2020 USD)



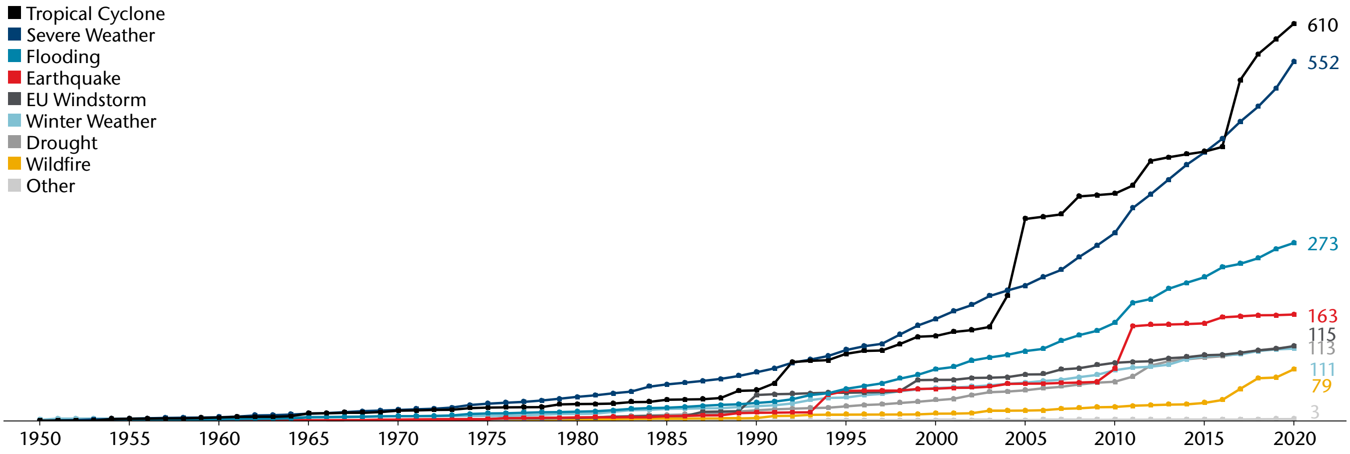
Data: Aon (Catastrophe Insight)

Exhibit 49: Global Insured Losses from natural disasters since 1950



Data: Aon (Catastrophe Insight)

Exhibit 50: Cumulative Global Insured Losses by peril since 1950 (2020 USD)



Data: Aon (Catastrophe Insight)

Appendix C: Historical Natural Disaster Events

The following tables provide a look at specific global natural disaster events since 1900. (Please note that the adjusted for inflation (2020 USD) totals were converted using the U.S. Consumer Price Index (CPI). Insured losses include those sustained by private industry and government entities such as the U.S. National Flood Insurance Program (NFIP). Inflation-adjusted losses are used since they represent actual incurred costs in today's dollars. Normalized values, while very valuable for analyzing historical scenarios using today's population, exposure, and wealth, are hypothetical. Please note that some of these values have been rounded to the nearest whole number.

For additional data, please visit **http://catastropheinsight.aon.com**.

Exhibit 51: Top 10 Costliest Global Economic Loss Events (1900-2020)

Date	Event	Location	Economic Loss[1] (Nominal USD)	Economic Loss[2] (2020 USD)
March 11, 2011	Tohoku EQ/Tsunami	Japan	235 billion	272 billion
January 16, 1995	Great Hanshin EQ	Japan	103 billion	176 billion
August 2005	Hurricane Katrina	United States	125 billion	165 billion
May 12, 2008	Sichuan Earthquake	China	122 billion	145 billion
August 2017	Hurricane Harvey	United States	125 billion	132 billion
September 2017	Hurricane Maria	Puerto Rico, Caribbean	90 billion	94 billion
October 2012	Hurricane Sandy	U.S., Caribbean, Canada	77 billion	86 billion
September 2017	Hurricane Irma	U.S., Caribbean	76 billion	80 billion
January 17, 1994	Northridge EQ	United States	44 billion	78 billion
November 23, 1980	Irpinia EQ	Italy	20 billion	61 billion

[1] *Economic loss include those sustained from direct damage, plus additional directly attributable event costs*
[2] *Adjusted using U.S. Consumer Price Index (CPI)*

Exhibit 52: Top 10 Costliest Global Insured Loss Events (1900-2020)

Date	Event	Location	Insured Loss[1] (Nominal USD)	Insured Loss[2] (2020 USD)
August 2005	Hurricane Katrina	United States	65 billion	86 billion
March 11, 2011	Tohoku EQ/ Tsunami	Japan	35 billion	41 billion
September 2017	Hurricane Irma	U.S, Caribbean	33 billion	35 billion
October 2012	Hurricane Sandy	United States	30 billion	34 billion
August 2017	Hurricane Harvey	United States	30 billion	32 billion
September 2017	Hurricane Maria	Puerto Rico, Caribbean	30 billion	31 billion
August 1992	Hurricane Andrew	U.S., Bahamas	16 billion	30 billion
January 17, 1994	Northridge EQ	United States	15 billion	27 billion
September 2008	Hurricane Ike	U.S., Caribbean	18 billion	22 billion
February 2011	Christchurch EQ	New Zealand	15 billion	18 billion

[1] *Losses sustained by private insurers and government-sponsored programs*
[2] *Adjusted using U.S. Consumer Price Index (CPI)*

Exhibit 53: Top 10 Costliest Tropical Cyclones: Economic Loss (1900-2020)

Date	Event	Location	Economic Loss[1] (Nominal USD)	Economic Loss[2] (2020 USD)
August 2005	Hurricane Katrina	United States	125 billion	165 billion
August 2017	Hurricane Harvey	United States	125 billion	132 billion
September 2017	Hurricane Maria	U.S., Caribbean	90 billion	94 billion
October 2012	Hurricane Sandy	U.S., Caribbean, Canada	77 billion	86 billion
September 2017	Hurricane Irma	U.S., Caribbean	76 billion	80 billion
August 1992	Hurricane Andrew	U.S., Bahamas	27 billion	50 billion
September 2008	Hurricane Ike	U.S., Caribbean	38 billion	45 billion
September 2004	Hurricane Ivan	U.S., Caribbean	27 billion	37 billion
October 2005	Hurricane Wilma	U.S., Caribbean	28 billion	36 billion
October 2018	Hurricane Michael	United States	26 billion	26 billion

[1] *Economic loss include those sustained from direct damage, plus additional directly attributable event costs*
[2] *Adjusted using U.S. Consumer Price Index (CPI)*

Exhibit 54: Top 10 Costliest Tropical Cyclones: Insured Loss (1900-2020)

Date	Event	Location	Insured Loss[1] (Nominal USD)	Insured Loss[2] (2020 USD)
August 2005	Hurricane Katrina	United States	65 billion	86 billion
September 2017	Hurricane Irma	U.S., Caribbean	33 billion	35 billion
October 2012	Hurricane Sandy	U.S., Caribbean, Canada	30 billion	34 billion
August 2017	Hurricane Harvey	United States	30 billion	32 billion
September 2017	Hurricane Maria	U.S., Caribbean	30 billion	31 billion
August 1992	Hurricane Andrew	U.S., Caribbean	16 billion	30 billion
September 2008	Hurricane Ike	U.S., Caribbean	18 billion	22 billion
October 2005	Hurricane Wilma	U.S., Caribbean	13 billion	16 billion
September 2004	Hurricane Ivan	U.S., Caribbean	11 billion	14 billion
September 2018	Typhoon Jebi	Japan	13 billion	14 billion

[1] *Losses sustained by private insurers and government-sponsored programs*
[2] *Adjusted using U.S. Consumer Price Index (CPI)*

Exhibit 55: Top 10 Costliest Severe Convective Storms: Economic Loss (1900-2020)

Date	Event	Location	Economic Loss[1] (Nominal USD)	Economic Loss[2] (2020 USD)
August 2020	SCS (incl. Midwest Derecho)	United States	13 billion	13 billion
April 2011	2011 Super Outbreak	United States	10 billion	12 billion
May 2011	Joplin Tornado/SCS	United States	9.1 billion	10 billion
April 1965	Palm Sunday Outbreak	United States	1.2 billion	9.9 billion
Oct-Nov 2018	Storm Vaia	Europe	8.3 billion	8.5 billion
April 1974	Super Outbreak 1974	United States	1.5 billion	8.2 billion
March 1973	United States SCS	United States	1.3 billion	7.5 billion
May 2003	United States SCS	United States	4.5 billion	6.3 billion
July 2013	Storm Andreas	Europe	5.3 billion	5.8 billion
April 1979	Texas Tornadoes & Flooding	United States	1.5 billion	5.5 billion

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

Exhibit 56: Top 10 Costliest Severe Convective Storms: Insured Loss (1900-2020)

Date	Event	Location	Insured Loss[1] (Nominal USD)	Insured Loss[2] (2020 USD)
April 2011	2011 Super Outbreak	United States	7.3 billion	8.4 billion
August 2020	SCS (incl. Midwest Derecho)	United States	8.3 billion	8.3 billion
May 2011	Joplin Tornado/SCS	United States	6.9 billion	7.9 billion
May 2003	United States SCS	United States	3.2 billion	4.5 billion
July 2013	Storm Andreas	Europe	3.8 billion	4.2 billion
May 2019	United States SCS	United States	3.7 billion	3.7 billion
April 2016	San Antonio Hailstorm	United States	3.2 billion	3.5 billion
June 2014	Storm Ela	Europe	3.1 billion	3.4 billion
April 2001	St. Louis Hailstorm	United States	2.2 billion	3.2 billion
May 2014	United States SCS	United States	3.0 billion	3.2 billion

[1] Losses sustained by private insurers and government-sponsored programs
[2] Adjusted using U.S. Consumer Price Index (CPI)

Exhibit 57: Top 10 Costliest Floods: Economic Loss (1900-2020)

Date	Event	Location	Economic Loss[1] (Nominal USD)	Economic Loss[2] (2020 USD)
June-December 2011	Thailand Floods	Thailand	45 billion	52 billion
June-September 1998	Yangtze River Floods	China	31 billion	50 billion
July-August 2010	Yangtze River Floods	China	35 billion	42 billion
June-August 1993	Mississippi Floods	United States	21 billion	38 billion
June-September 2020	China Seasonal Floods	China	35 billion	35 billion
July-August 1931	Yangtze River Floods	China	2.0 billion	34 billion
June-August 1953	Japan Floods	Japan	3.2 billion	31 billion
May-August 2016	Yangtze River Floods	China	28 billion	30 billion
May-September 1991	Yangtze River Floods	China	14 billion	26 billion
July 1995	North Korea Floods	North Korea	15 billion	25 billion

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

Exhibit 58: Top 10 Costliest Earthquakes: Economic Loss (1900-2020)

Date	Event	Location	Economic Loss[1] (Nominal USD)	Economic Loss[2] (2020 USD)
March 11, 2011	Tohoku EQ/Tsunami	Japan	235 billion	271 billion
January 16, 1995	Great Hanshin EQ	Japan	103 billion	176 billion
May 12, 2008	Sichuan EQ	China	122 billion	145 billion
January 17, 1994	Northridge EQ	United States	44 billion	78 billion
November 23, 1980	Irpinia EQ	Italy	20 billion	61 billion
April 14, 2016	Kumamoto EQ	Japan	38 billion	41 billion
October 23, 2004	Chuetsu EQ	Japan	28 billion	38 billion
February 27, 2010	Chile EQ	Chile	30 billion	36 billion
December 7, 1988	Armenian EQ	Armenia (Present Day)	16 billion	35 billion
July 27, 1976	Tangshan EQ	China	6.8 billion	31 billion

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

Exhibit 59: Top 10 Costliest Individual Wildfires: Insured Loss (1900-2020)

Date	Event	Location	Insured Loss[1] (Nominal USD)	Insured Loss[2] (2020 USD)
November 2018	Camp Fire	United States	10 billion	10 billion
October 2017	Tubbs Fire	United States	8.7 billion	9.1 billion
November 2018	Woolsey Fire	United States	4.2 billion	4.3 billion
October 1991	Oakland (Tunnel) Fire	United States	1.7 billion	3.2 billion
October 2017	Atlas Fire	United States	3.0 billion	3.1 billion
May 2016	Horse Creek Fire	Canada	2.8 billion	3.1 billion
September-October 2020	Glass Fire	United States	2.9 billion	2.9 billion
August-September 2020	CZU Lightning Complex Fire	United States	2.4 billion	2.4 billion
December 2017	Thomas Fire	United States	2.2 billion	2.4 billion
October 2007	Witch Fire	United States	1.6 billion	2.0 billion

[1] *Losses sustained by private insurers and government-sponsored programs*
[2] *Adjusted using U.S. Consumer Price Index (CPI)*

Exhibit 60: Top 10 Global Human Fatality Events in the Modern Era (1950-2020)

Date	Event	Location	Economic Loss[1,2] (2020 USD)	Fatalities
November 12, 1970	Cyclone Bhola	Bangladesh	86 million	300,000
July 27, 1976	Tangshan EQ	China	6.8 billion	242,769
July 30, 1975	Super Typhoon Nina	Taiwan, China	1.2 billion	230,000
December 26, 2004	Indian Ocean EQ/Tsunami	Indian Ocean Basin	19 billion	227,899
January 12, 2010	Port-au-Prince EQ	Haiti	8.0 billion	160,000
April 1991	Cyclone Gorky	Bangladesh	1.8 billion	139,000
May 2008	Cyclone Nargis	Myanmar	13 billion	138,366
August 1971	Vietnam Floods	Vietnam	N/A	100,000
October 8, 2005	Kashmir EQ	Pakistan	6.7 billion	88,000
May 12, 2008	Sichuan EQ	China	122 billion	87,652
May 31, 1970	Ancash EQ	Peru	530 million	66,794

[1] *Economic loss include those sustained from direct damage, plus additional directly attributable event costs*
[2] *Adjusted using U.S. Consumer Price Index (CPI)*

Appendix D: Global Tropical Cyclone Activity

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

Global Landfall Trends

Please note that 1990 is generally considered the first year when global tropical cyclone data are best verified in every basin. Data from the Southern Hemisphere prior to 1990 is still subject to future reanalysis by official tropical cyclone agencies.

Exhibit 61: Global Tropical Cyclone Landfalls (Category 1+)

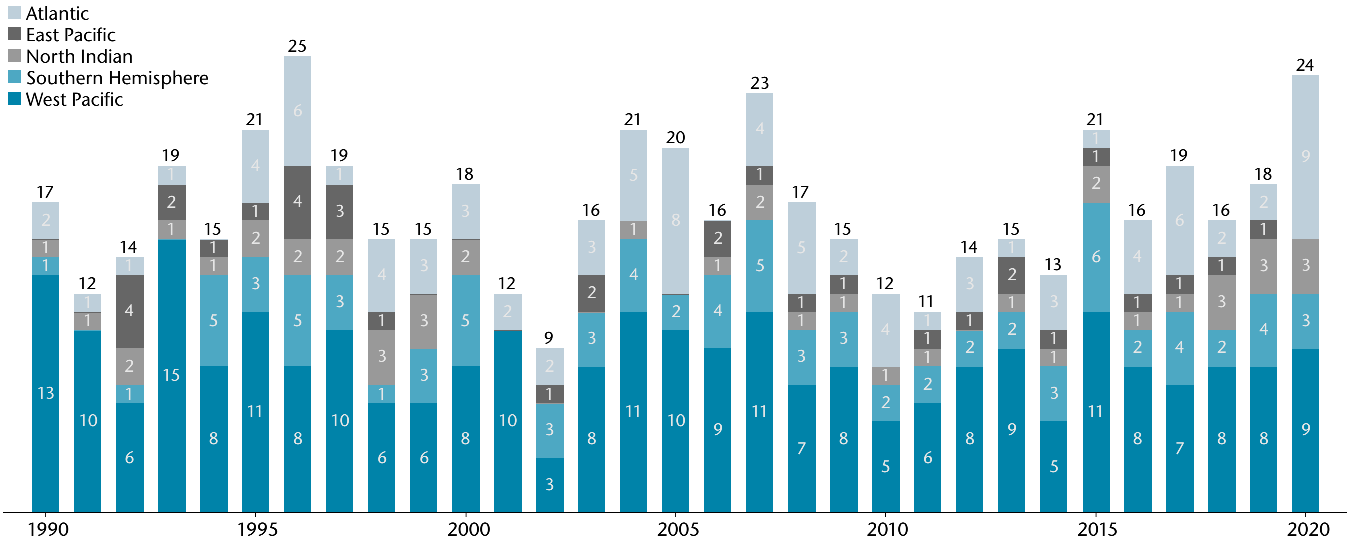


Exhibit 62: Global Tropical Cyclone Landfalls (Category 3+)

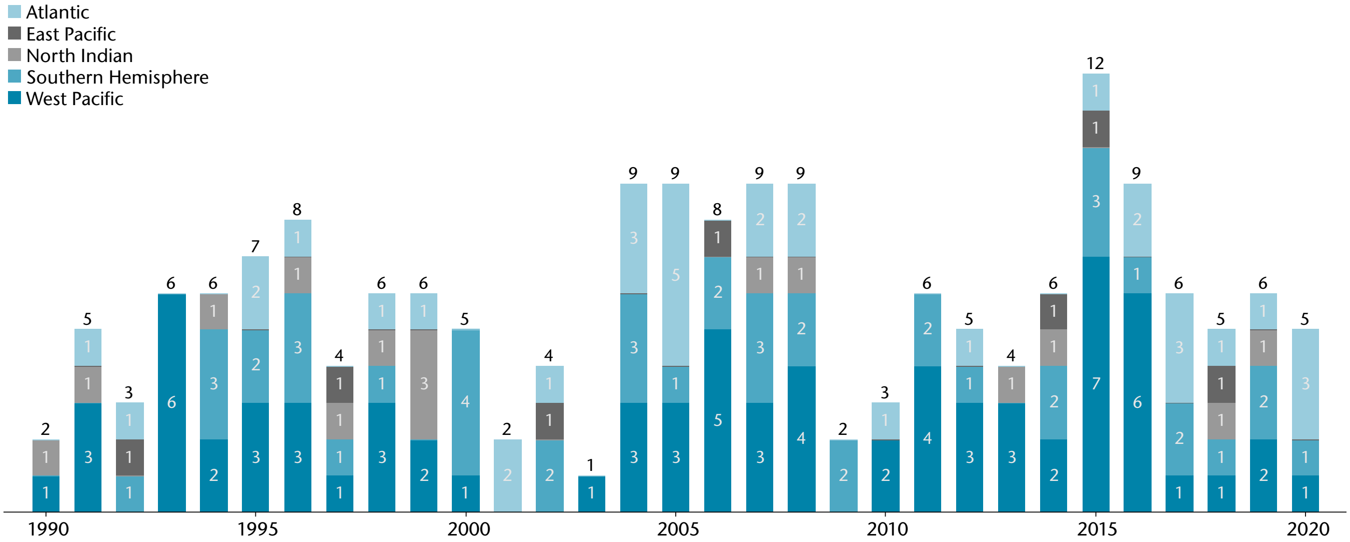
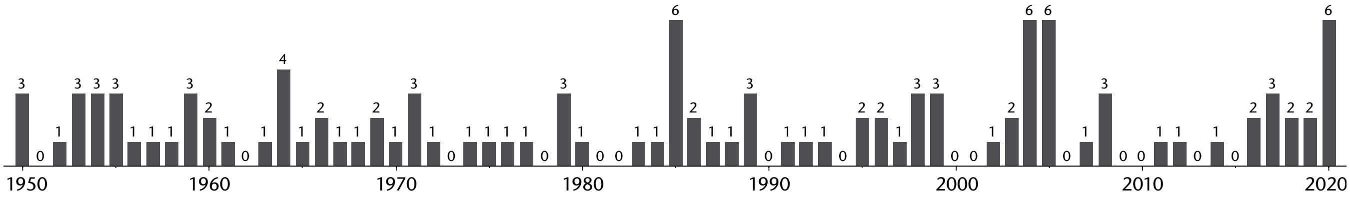


Exhibit 63: United States Hurricane & Major Hurricane Landfalls

Category 1+ (≥74 mph / 119 kph)



Category 3+ (≥111 mph / 179 kph)

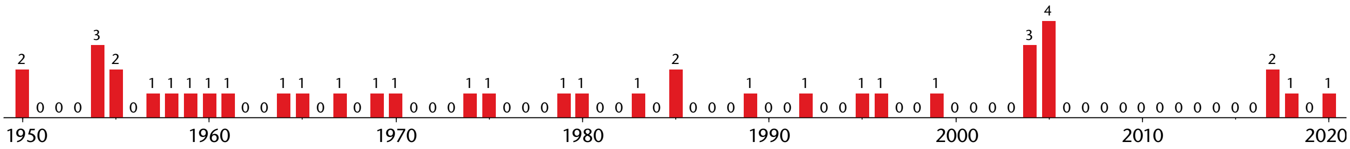
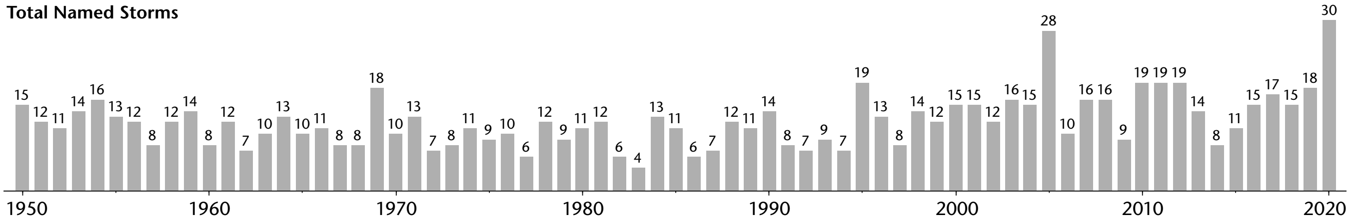
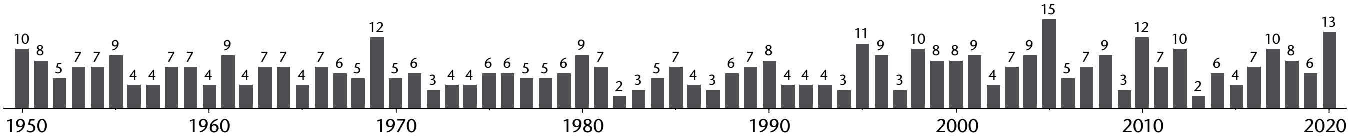


Exhibit 64: Atlantic Basin Tropical Cyclone Activity

Total Named Storms



Category 1+ (≥74 mph / 119 kph)



Category 3+ (≥111 mph / 179 kph)

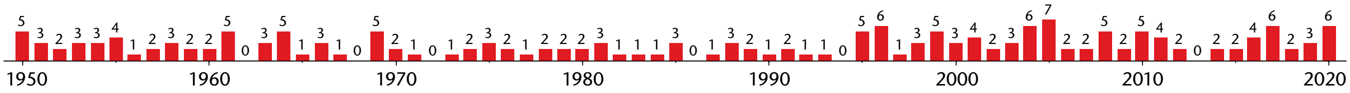
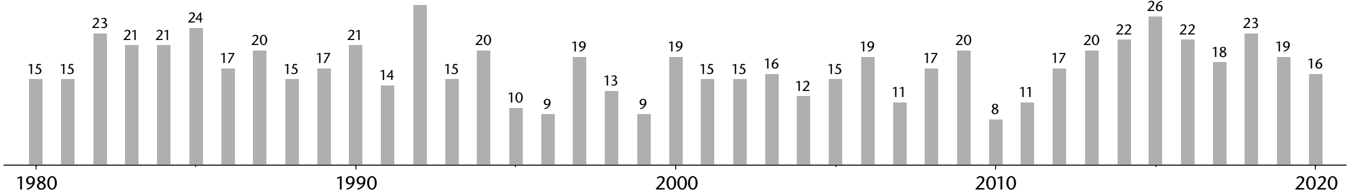
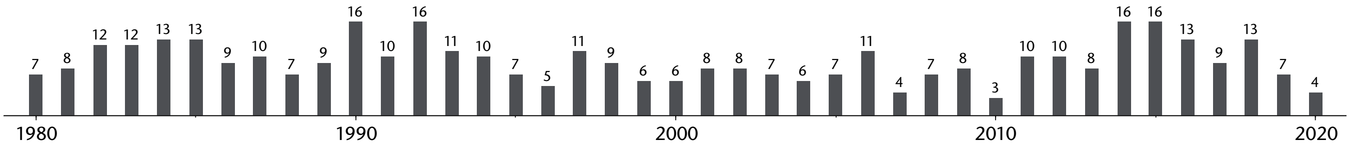


Exhibit 65: Eastern & Central Pacific Basin Tropical Cyclone Activity

Total Named Storms



Category 1+ (≥74 mph / 119 kph)



Category 3+ (≥111 mph / 179 kph)

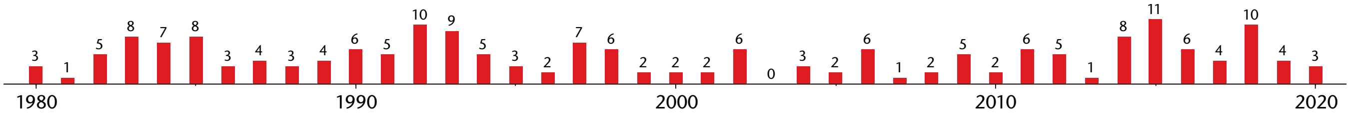
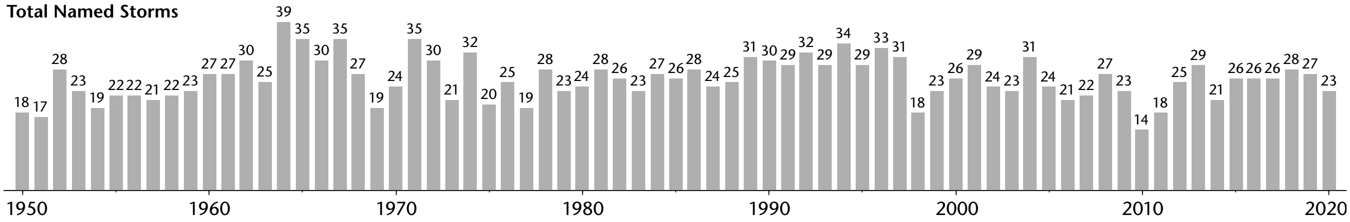
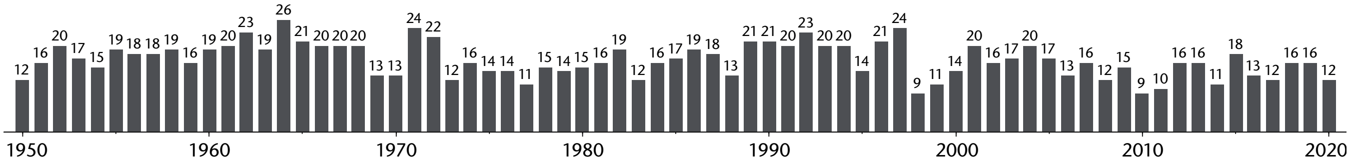


Exhibit 66: Western Pacific Basin Tropical Cyclone Activity

Total Named Storms



Category 1+ (≥74 mph / 119 kph)



Category 3+ (≥111 mph / 179 kph)

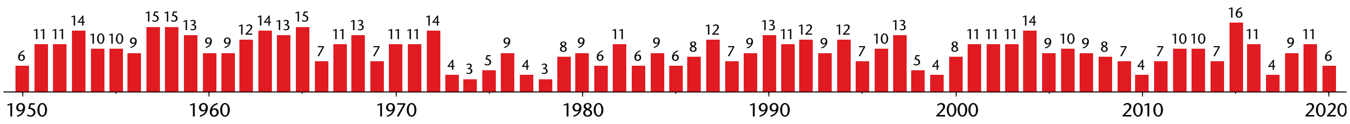
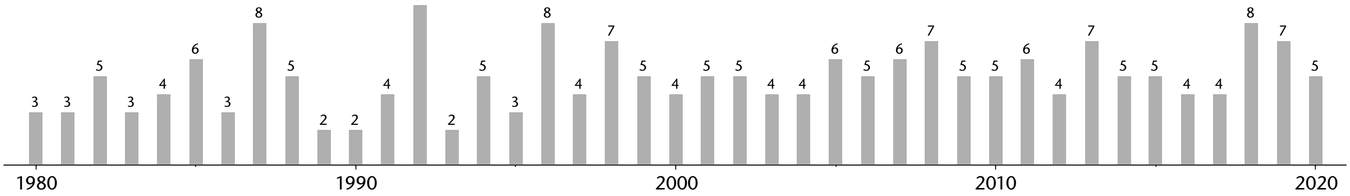
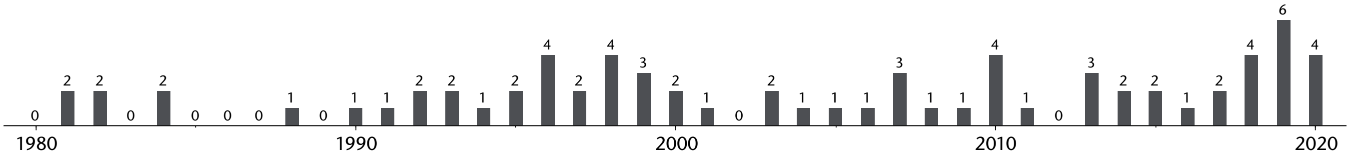


Exhibit 67: North Indian Basin Tropical Cyclone Activity

Total Named Storms



Category 1+ (≥74 mph / 119 kph)



Category 3+ (≥111 mph / 179 kph)

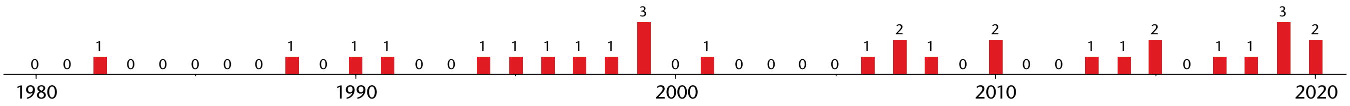
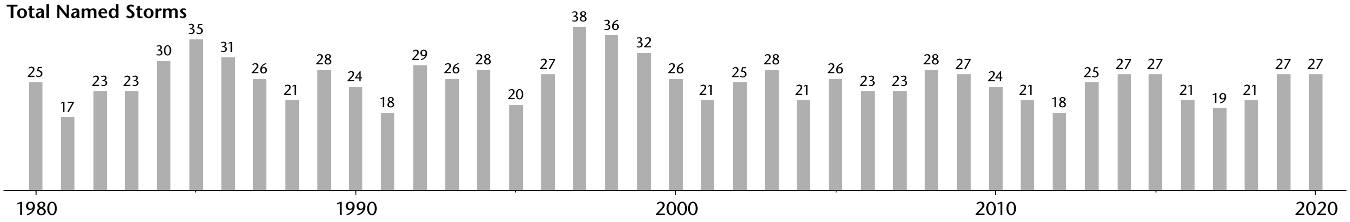
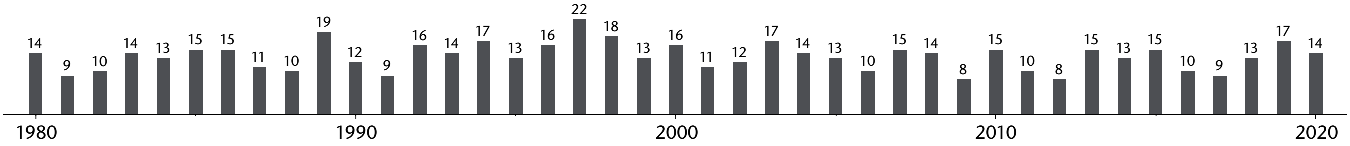


Exhibit 68: Southern Hemisphere Tropical Cyclone Activity

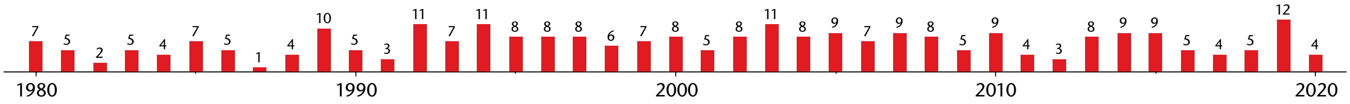
Total Named Storms



Category 1+ (≥74 mph / 119 kph)



Category 3+ (≥111 mph / 179 kph)



Appendix E: United States Severe Weather Data

Given the increased cost of severe weather-related damage in the United States during the past decade for insurers, the following is a breakout of tornadoes, tornado fatalities, large hail (2.0” or larger), and damaging straight-line winds (75 mph or greater). The data comes via NOAA’s Storm Prediction Center. Please note that data prior to 1990 are often considered incomplete given a lack of reporting. ***The implementation of Doppler radar, greater social awareness and increased reporting has led to more accurate datasets in the last 30 years.*** Data from 2020 is to be considered preliminary.

Exhibit 69: U.S. Tornadoes

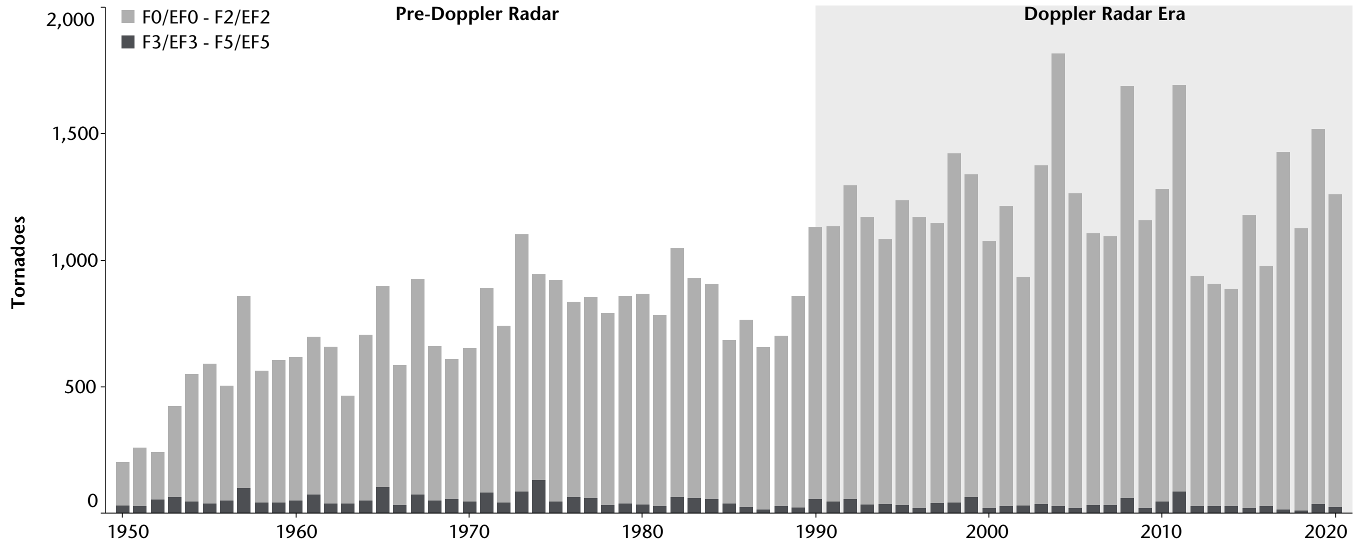


Exhibit 70: U.S. Tornado (F3/EF3+)

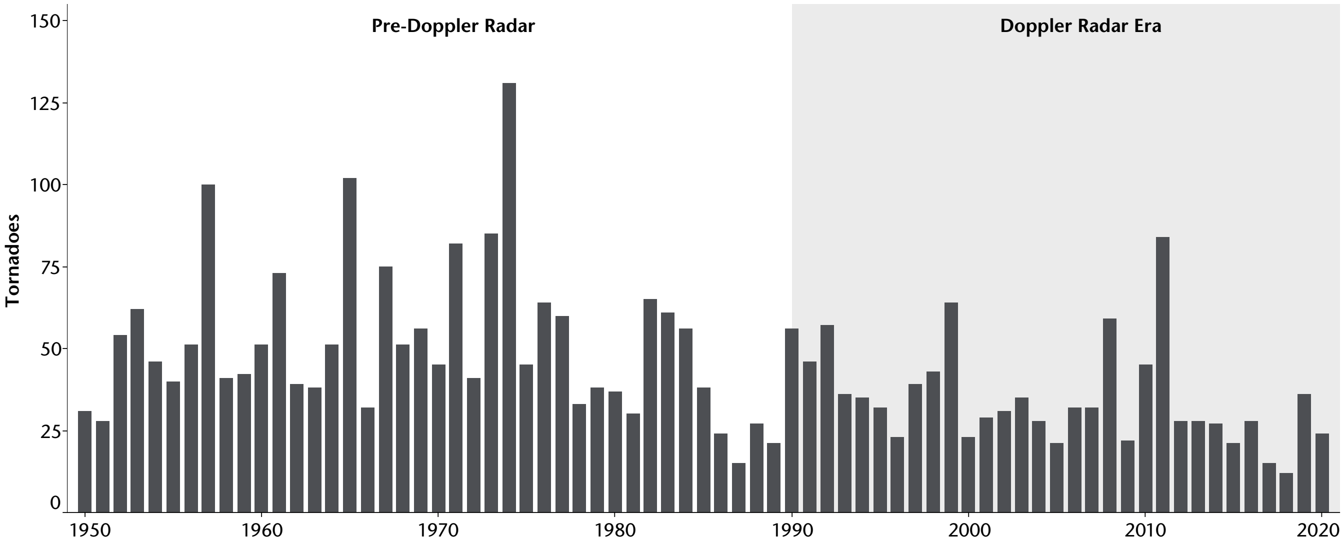
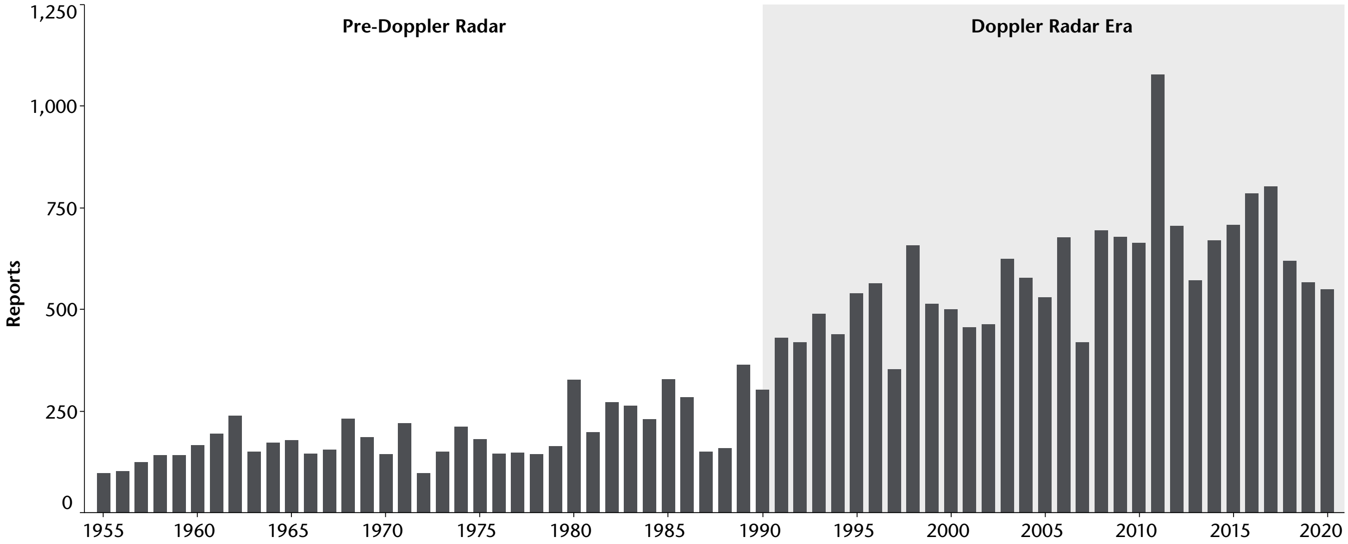


Exhibit 71: U.S. Large Hail Reports (2.0" or Larger)



Appendix F: Global Earthquakes

Based on historical data from the United States Geological Survey, there were at least nine earthquakes in 2020 with magnitudes of 7.0 or greater. Overall earthquake activity does not often show large fluctuations on an annual basis. This is especially true given the extensive network of global seismograph stations that has led to an improved and more robust dataset in recent decades.

Exhibit 72: Global Earthquakes (M7.0+)

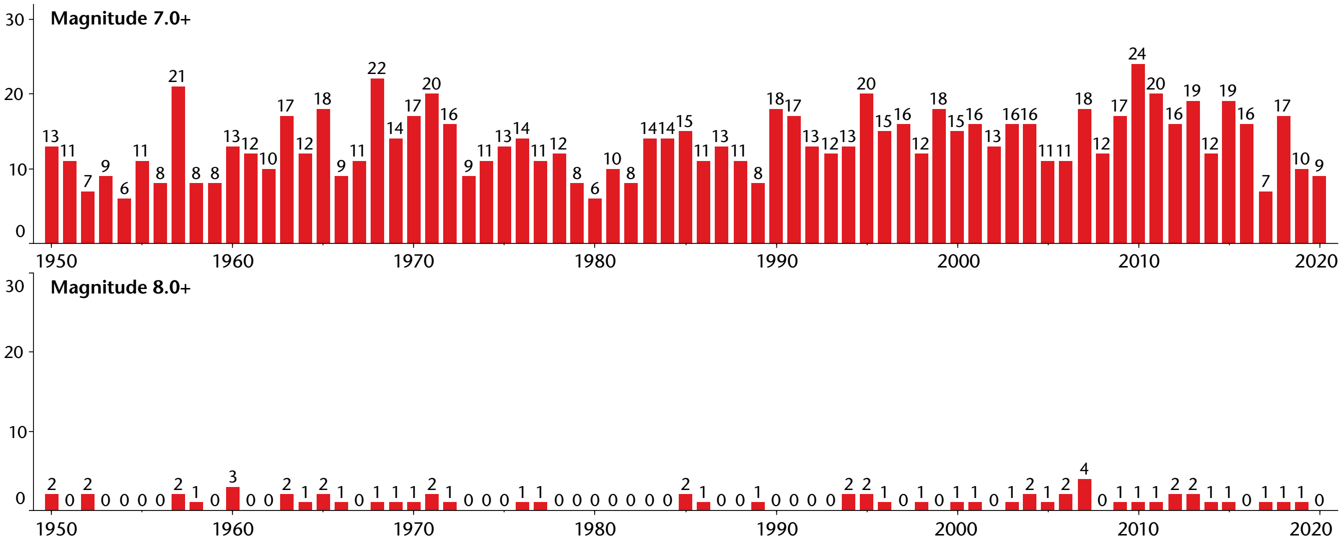
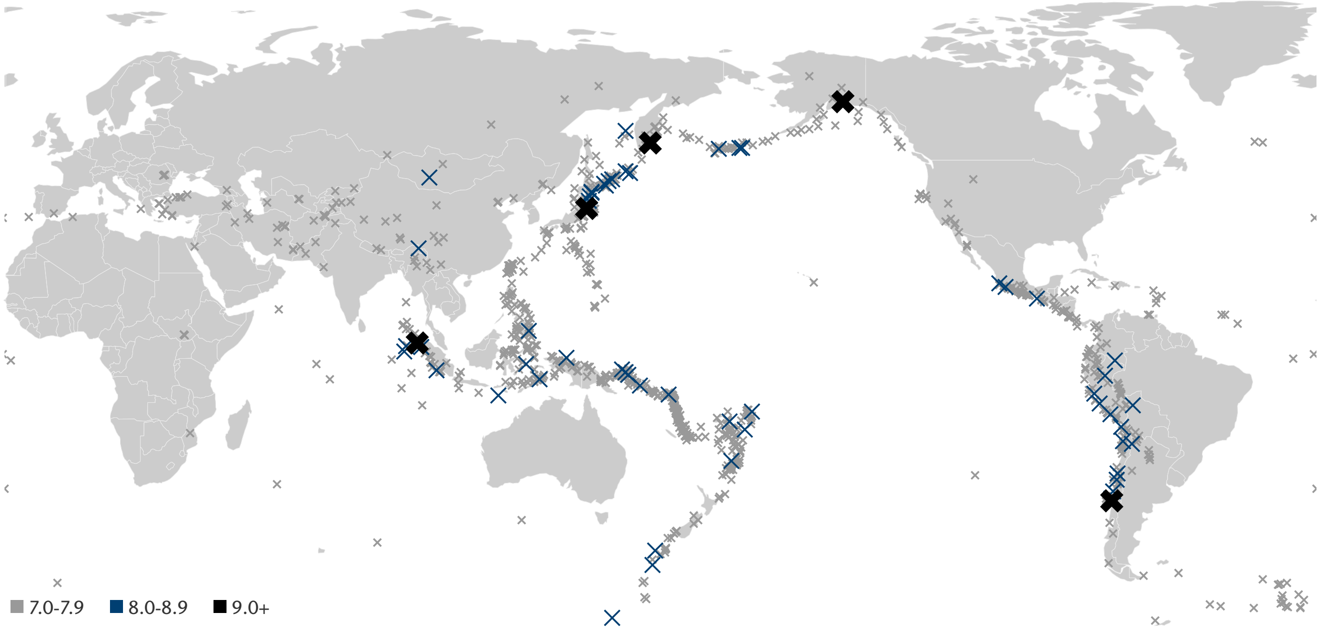


Exhibit 73: Global Earthquake Map; M7.0+ (1950-2019)



Appendix G: United States & Europe Wildfire Data

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

Exhibit 74: United States Wildfire Acres Burned & Acres Burned per Fire

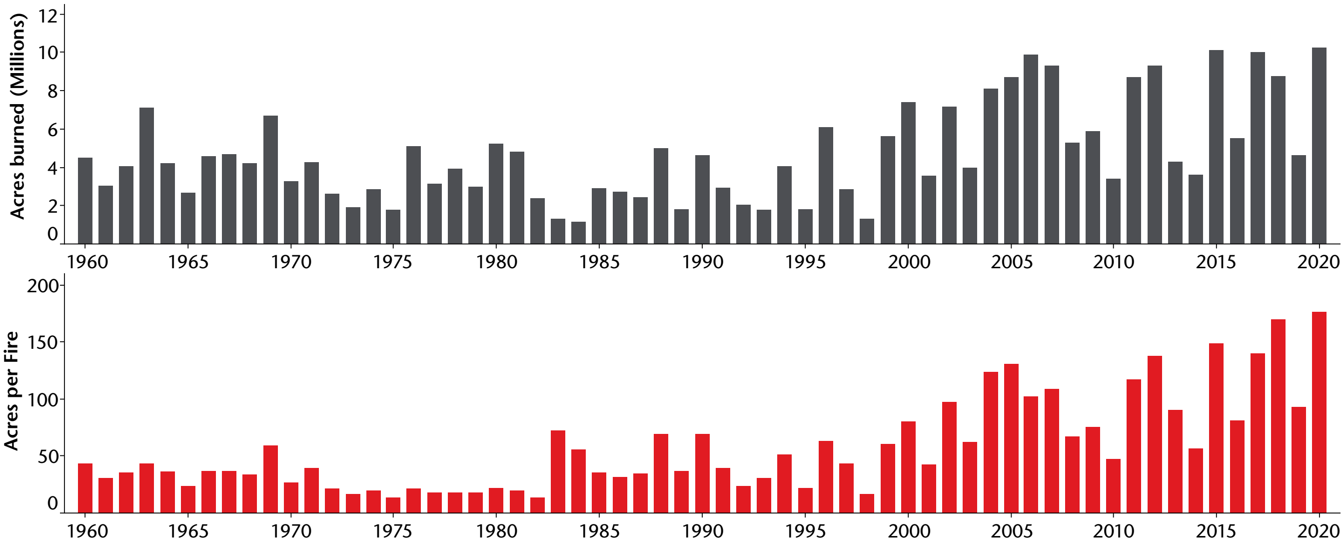
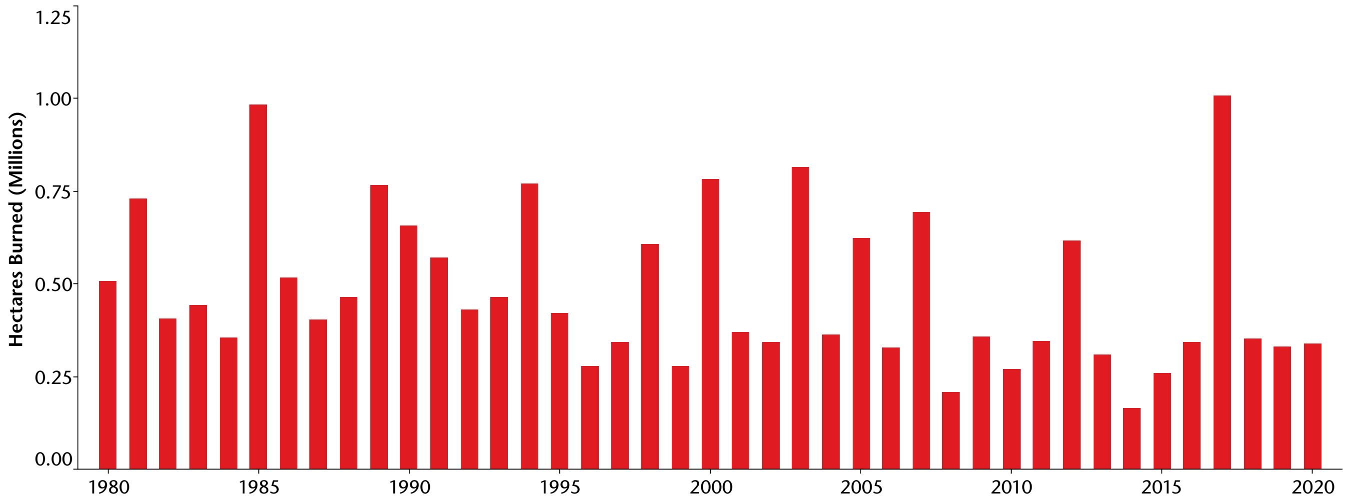


Exhibit 75: Area burned by Forest Fires in the European Union & UK



Additional Report Details

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

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

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

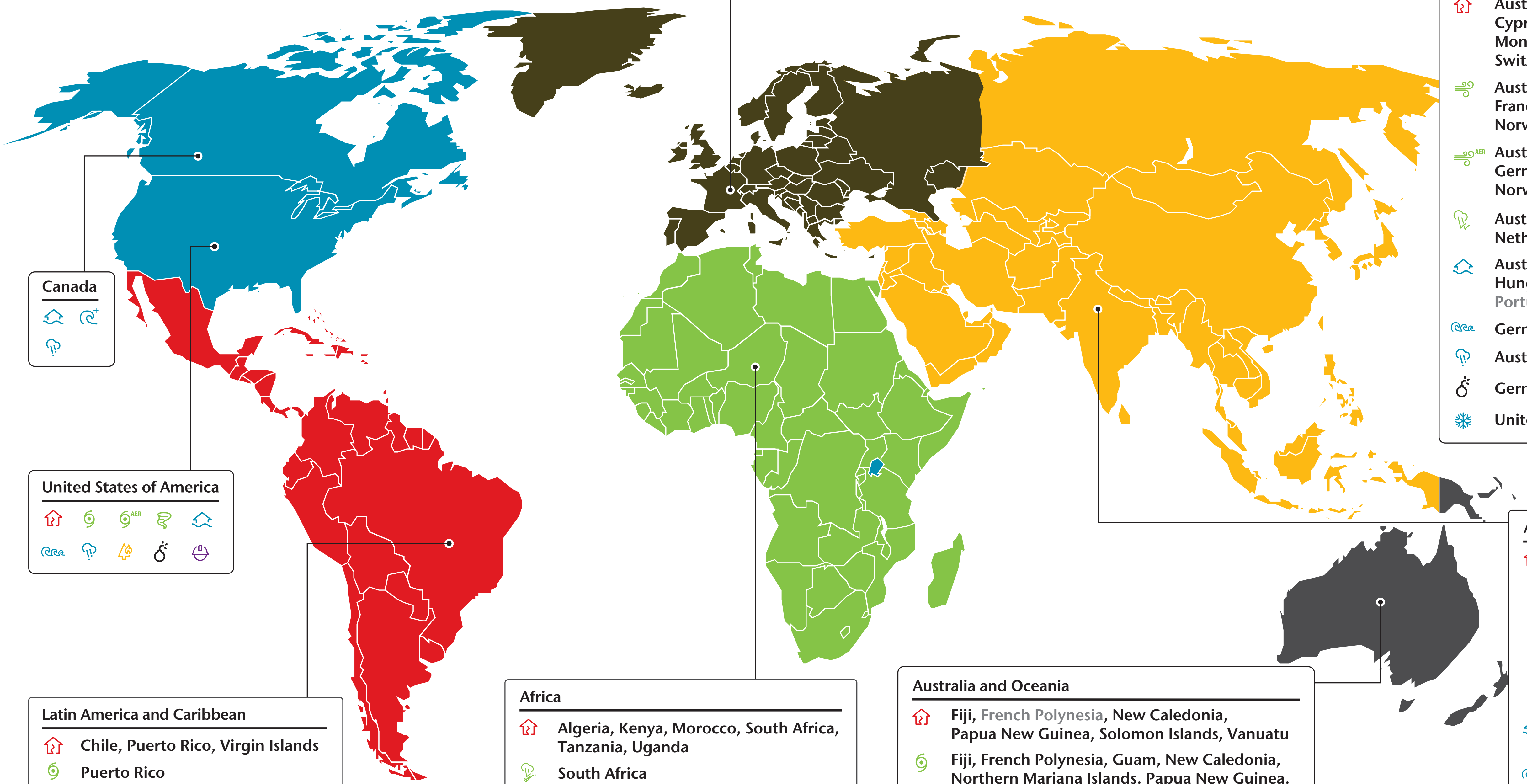
Damage estimates are obtained from various public media sources, including news websites, publications from insurance companies, financial institution press releases and official government agencies. Economic loss totals include any available insured loss estimates, which can be found in the corresponding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

This report uses publicly available data from the internet and other sources. Impact Forecasting® summarizes this publicly available

information for the convenience of those individuals who have contacted Impact Forecasting® and expressed an interest in natural catastrophes of various types. To find out more about Impact Forecasting or to sign up for the Cat Reports, visit Impact Forecasting's webpage at **www.impactforecasting.com**.

Scan here to access all editions of the Annual Global Climate and Catastrophe Report

Impact Forecasting Model Coverage Map



Canada

⌂ ↺+

🌧

United States of America

🏚 🌀 🌀AER 🌪 ⌂

🌊 🌧 🔥 💣 ⛑

Latin America and Caribbean

- 🏚 Chile, Puerto Rico, Virgin Islands
- 🌀 Puerto Rico
- ⌂ Brazil, Mexico, Entire territory
- ↺ Chile

Africa

- 🏚 Algeria, Kenya, Morocco, South Africa, Tanzania, Uganda
- 🌨 South Africa
- ⌂ South Africa
- 🌧 South Africa

Australia and Oceania

- 🏚 Fiji, French Polynesia, New Caledonia, Papua New Guinea, Solomon Islands, Vanuatu
- 🌀 Fiji, French Polynesia, Guam, New Caledonia, Northern Mariana Islands, Papua New Guinea, Solomon Islands, Vanuatu
- ⌂ Australia, Australia+

Europe

- 🏚 Austria, Bosnia and Herzegovina, Bulgaria, Croatia, Cyprus, Germany, Greece, Hungary, Iceland, Montenegro, Romania, Serbia, Slovakia, Slovenia, Switzerland
- 💨 Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Ireland, Luxembourg, Netherlands, Norway, Poland, Slovakia, Sweden, United Kingdom
- 💨AER Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Luxembourg, Netherlands, Norway, Sweden, United Kingdom
- 🌨 Austria, Belgium, Czech Republic, France, Germany, Netherlands, Poland, Slovenia, Switzerland
- ⌂ Austria, Czech Republic, France, Germany, Hungary, Liechtenstein, Netherlands, Poland, Portugal, Slovakia, Switzerland, United Kingdom+
- 🌊 Germany, Netherlands, United Kingdom+
- 🌧 Austria, Sweden
- 💣 Germany, United Kingdom
- ❄ United Kingdom

Asia

- 🏚 Bahrain, Indonesia, Iran, Israel, Kazakhstan, Kuwait, Nepal, Oman, Pakistan, Philippines, Qatar, Saudi Arabia, Singapore, Thailand, Turkey, United Arab Emirates, Yemen
- 🌀 China, Hong Kong, India, Malaysia, Philippines, South Korea, Taiwan, Thailand, Vietnam
- ⌂ China, India, Indonesia, Japan, Malaysia, Saudi Arabia, Thailand, Vietnam
- 🌊 Vietnam
- 🌧 China, Indonesia, Malaysia, Saudi Arabia, Vietnam

Map Icons

- 🏚 earthquake
- 🌀 tropical cyclone
- 🌪 severe convective storm
- 💨 windstorm
- 🌨 hail
- ⌂ fluvial flood
- 🌊 storm surge
- ❄ freeze
- ↺ tsunami
- 🌧 pluvial flood / cloudburst
- 🔥 brushfire
- 💣 terrorism
- ⛑ workers' compensation

AER Automated Event Response
Country scenario model only
\+ third party models

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About Impact Forecasting

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

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