AON

2024

Climate and Catastrophe Insight

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Executive Summary

Economic Losses

$380B

22% above the 21st century average

69%

global protection gap

398

number of notable disaster events

66

billion-dollar economic loss events: above the average of 42 and the highest on record

Insured Losses

$118B

31% above the 21st century average

67%

of global insured losses were recorded in the United States

37

billion-dollar insured loss events: above the average of 14 and the highest on record

$3.5B

insured loss from Hawaii wildfire

$92B/$5.7B

economic/insured losses from Turkey and Syria earthquakes — the costliest event of the year

95,000

number of fatalities: highest since 2010, driven largely by earthquakes and heatwaves

19 cm (7.5 in)

diameter of the largest hailstone ever recorded in Europe on July 24

Earthquake

peril with the highest economic losses; severe convective storms were the most damaging peril for insurers

New Zealand, Italy, Greece, Slovenia and Croatia

recorded the costliest weather-related insurance events on record

1.45 °C (2.61 °F)

temperature anomaly in 2023 compared to pre-industrial period (1850-1900), marking the warmest year on record

7

unprecedented number of the warmest months on record between June-December

24

countries and territories that recorded their highest temperatures

105.2 °C (189.4 °F)

difference between new all-time maximum and minimum temperature in China, both set this year

Executive Summary

Nearly 400 natural disasters and an evolving climate reveal vulnerabilities and opportunities across the globe.

Economic losses were above average due to devastating earthquakes.

Global natural disasters in 2023 resulted in above-average economic losses totaling $380 billion, which was driven by significant earthquakes and relentless severe convective storm activity in the United States and Europe. The single most catastrophic event was the earthquake sequence that hit Turkey and Syria in February. Global losses surpassed $300 billion for the eighth time in a row and were 22 percent higher than the long-term average. Considering weather-related disasters only, the global total was close to long-term and slightly below the decadal averages.

Severe convective storms were the most damaging peril for insurers.

Insurers across the world covered $118 billion, which was above the 21st century average ($90 billion), as well as the decadal mean ($110 billion). U.S. drought and the earthquake sequence in Turkey and Syria were the costliest events for insurance, considering both public and private entities. While no event reached the 10-billion-dollar mark, there were at least 37 billion-dollar disasters in total, marking a new historical record. This underlines the growing frequency of medium-sized events, particularly severe convective storms, and their impact on global losses. SCS was the most damaging peril for insurers.

New Zealand, Italy, Greece, Slovenia and Croatia all recorded their costliest weather-related insurance events on record.

The global protection gap increased to average levels in 2023, after the lowest gap on record in 2022. Significant regional differences still exist: The majority of disaster losses are covered in the United States, but most of the losses in EMEA, APAC and Americas are still uninsured. This shows that closing the protection gap will continue to pose a challenge but also a huge opportunity for certain regions.

The human toll was the highest since 2010.

The year 2023 was the deadliest since 2010, which was driven by more than 64,000 fatalities from earthquakes. Multiple significant heatwaves around the globe resulted in at least 16,500 heat-related deaths.

2023 was the hottest year on record.

Extremely high temperature anomalies recorded in many parts of the globe resulted in 2023 being reported as the warmest year on record. This became emblematic while a variety of other climate statistics were rewritten amid the wider process of a changing climate. Behavior of many natural perils continued to be affected not only by the warming trend, but also by the El Niño conditions during the year.

Many significant events highlighted the need for better disaster preparedness and planning to reduce risk, protect lives and promote resilience.

Three Ways to Address Climate Risks Today

Foreword from Greg Case, CEO, Aon

Climate risk is a certainty, not a probability. Throughout 2023, wildfires across Europe and North America, flooding in Asia and record-breaking heatwaves in the U.S. and Latin America demonstrated that severe weather and climate-related risks now pose an existential threat to the way we live and work.

Out of the 66 natural catastrophes that caused a billion dollars or more in damages in 2023, 63 of them were caused by weather. Yet only 40 percent of weather and climate-related losses were covered by insurance in 2023. There is a tremendous opportunity to close this protection gap, provide real value to clients, and fundamentally strengthen the impact of our industry on how society responds to severe weather and climate risks.

These are challenges today, not problems down the road. However, while many organizations have seen the threat, they have yet to take any action. Climate underpins many of the risks identified by the nearly 3,000 risk managers, C-suite leaders and other executives who participated in our 2023 Global Risk Management Survey. Still, these leaders only rank climate as a top 10 risk when they looked into the future. Rather than waiting for a disaster to strike, leaders can prepare their organizations to address climate risk to increase the resiliency of their operations, workforces and the communities they impact.

Catalysts to Address Climate Risks

We have identified three catalysts that accelerate the ability of our clients to address climate risks:

1. **Predictive analytics unlock the capability to price future risk**

   Unlike traditional catastrophe models, which often leverage historical data to identify near-term risk, climate risk models are designed to be forward-looking and quantify how climate change affects the frequency and severity of rare, but costly events.

   At Aon, we brought together more than 1,000 analytics professionals for the first time across our Risk Capital and Human Capital capabilities to present clients with an integrated view of market dynamics in fundamental areas like property risk.

   Climate analytics can provide forward-looking diagnostics for a range of scenarios. For example, hazard data can be applied to specific locations where a company has assets, giving them a better understanding of their current and future risks. As well as helping to address the physical risks of climate, advanced analytics can also provide more clarity for the voluntary carbon market and help finance the energy transition through innovation.

2. **Collaboration is essential to developing effective solutions**

   Because climate risk is such a complex problem, no single industry or discipline can solve it alone. Businesses, governments and the scientific community are realizing that they need to bring all of their capabilities together to address climate risk. To this end, Aon recently became the first member with Risk Capital capabilities to join the International Emissions Trading Association, which is dedicated to building an international framework for trading in greenhouse gas emission reductions.

   Another area of collaboration — and where we feel we have the biggest impact — is working with our clients across the reinsurance and commercial risk space to help them quantify and mitigate their unique risks and transition to a low-carbon future.

3. **Innovation is key to accelerating the path to net zero**

   Businesses are important foundational partners to help fund and promote innovation as we build toward a low-carbon future. Aon has made commitments of its own to help make the world more sustainable by pledging to achieve net-zero greenhouse gas emissions by 2030, for example. To tackle climate risk and bring about a true net-zero economy, an estimated $150 trillion in capital will need to be deployed over the next 30 years. We've observed that capital is hesitant to go where it is not protected or where returns are less certain. The insurance industry can play a pivotal role in unlocking and speeding up the flow of capital into green investments and volatility management through innovative risk transfer programs.

We hope you enjoy reading Aon's 2024 Climate and Catastrophe Insight report for an in-depth, data-driven look at the importance of addressing the growing protection gap, accelerating climate solutions and mitigating against physical risk to protect assets.

Greg Case
CEO, Aon

How This Report Can Help Build and Promote Resilience

This report analyzes the global natural hazards of 2023 to quantify the risk and human impact of climate change, socioeconomics and other emerging issues. Our goal is to help navigate volatility, enhance resilience and make better decisions. The data and analysis is designed to better inform various sectors, including insurance, government, academia, construction and finance as we collaboratively build a more resilient future to protect people and property.

Identify Trends

a. Explore global and regional catastrophe loss drivers

b. Quantify the cost in geographies with higher annual or decadal losses

c. Detect climate change influence on individual event behavior and impacts

Enhance Risk Mitigation

a. Better establish risk mitigation efforts in the public and private sectors — especially in the most vulnerable areas of the world — for enhanced disaster response and business continuity

b. Modernize building codes and mandate enforcement to prevent human loss

c. Improve risk communication and explanation of uncertainty

d. Academic collaborations in climate research will help develop new tools and solutions to lower risk and promote future mitigation and adaptation practices

Seize the Opportunities

a. Explore traditional and alternative insurance to protect people and assets

b. Grow the volume of assets dedicated to sustainable investment to accelerate green initiatives that will meet net-zero emissions goals

c. Economic, social and governance strategies to assess, disclose and manage risks, including climate

d. Build resilience through public-private collaborations to close the protection gap, protecting and enriching lives around the world

Take a Deeper Dive into Our Spotlight Features to Explore Key Learnings for 2024

a. Organizations can leverage analytics to unlock capital such as innovative parametric solutions to protect their people and property, while closing the protection gap

b. New buildings are leveraging technology and renewable energy to meet climate resiliency goals, reinforcing how building structural integrity and infrastructure investments are crucial to driving adaption and protecting people

c. The insurance industry plays a crucial role in helping individuals, businesses and governments adapt to, and mitigate the impact of, climate change and the transition from brown to green energy

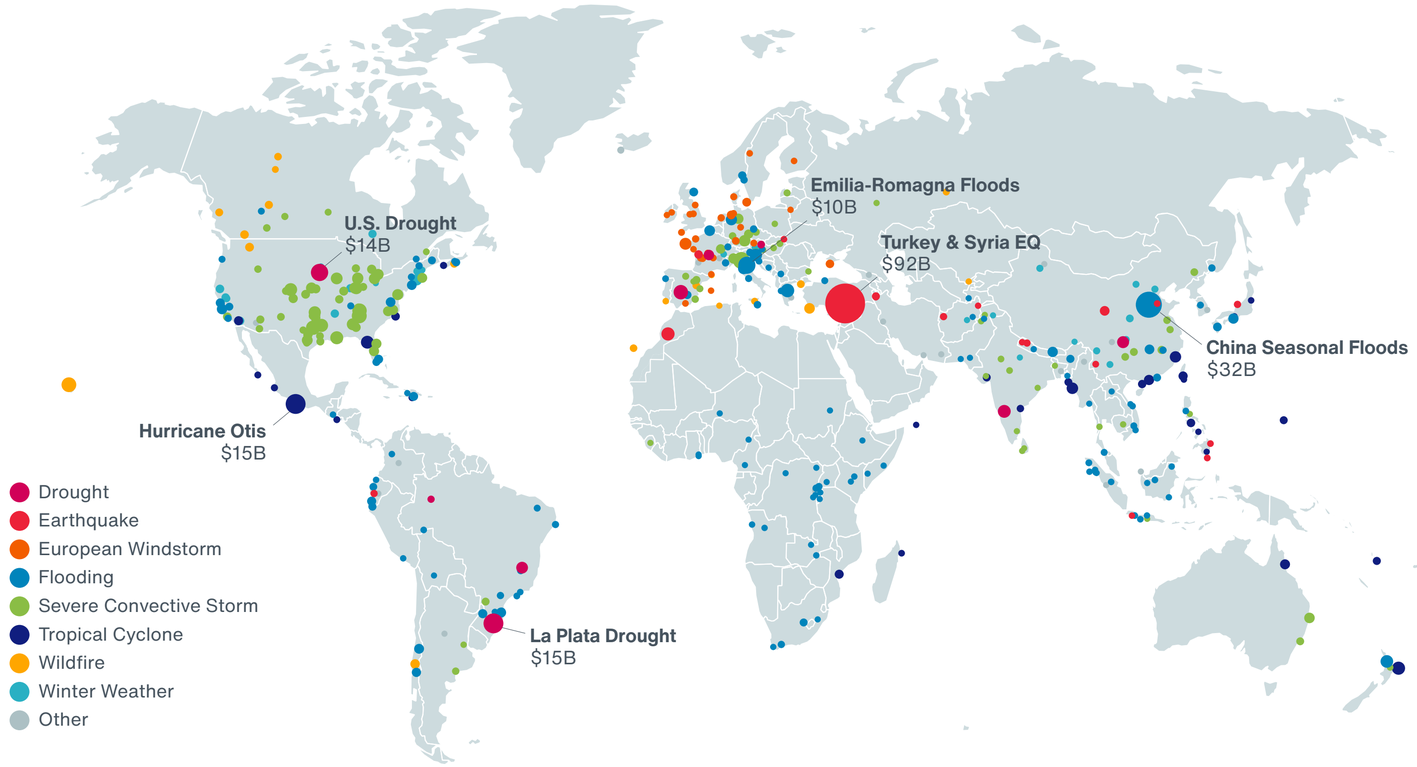
d. Investors must consider climate change in terms of protecting their portfolios against financial risk, benefiting from growth opportunities in emerging solutions and how to decarbonize the real economy

2023 Natural Disaster Events and Loss Trends

The major natural disaster events of 2023 and the long-term trends for losses and human casualties.

Global Economic Losses Above the 21st Century Average

Exhibit 1: Notable 2023 Economic Loss Events



Data: Aon Catastrophe Insight

Economic losses from global natural disasters in 2023 are estimated at $380 billion, above long-term and short-term averages, after adjusting historical losses to today's values using the U.S. Consumer Price Index.

All continents recorded remarkable natural disaster events in 2023 and multiple countries faced the most significant disasters in their modern histories.

The global map shows event and peril patterns that contributed to the overall economic losses in 2023. The largest loss driver was earthquake, yet this was largely caused by a handful of events, notably the earthquake sequence in Turkey and Syria. Severe convective storms came second, with the largest individual losses concentrated in the United States and Europe.

At the same time, the global map also shows that direct economic impacts from disasters are concentrated in areas with higher economic output. However, focusing solely on the financial aspect of disasters does not reflect their overall humanitarian impact on societies, particularly in developing countries.

Note that significant price inflation throughout the year already resulted in notable increases of per-event losses.

Exhibit 2: Top 10 Global Economic Loss Events in 2023

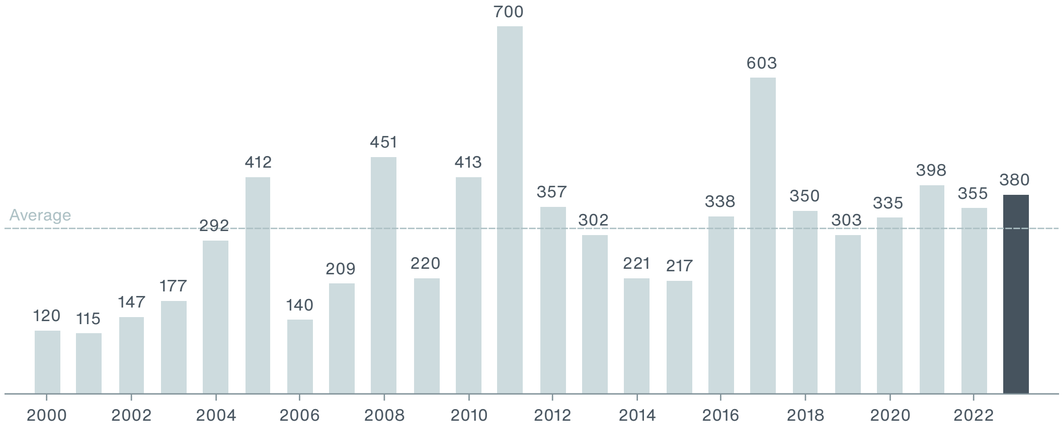
Date	Event	Location	Deaths	Economic Loss ($ billion)	Insured Loss ($ billion)
02/06-02/20	**Turkey and Syria Earthquakes**	Turkey and Syria	59,272	**92.4**	5.7
05/22-09/30	**China Floods**	China	370	**32.2**	1.4
10/25-10/26	**Hurricane Otis**	Mexico	52	**15.3**	2.1
01/01-06/30	**La Plata Basin Drought**	Brazil, Argentina, Uruguay	N/A	**15.3**	1.0
01/01-12/31	**U.S. Drought**	United States	N/A	**14.0**	6.5
05/13-05/17	**Emilia-Romagna Floods**	Italy	15	**9.8**	0.6
03/01-03/03	**Severe Convective Storm**	United States	13	**6.2**	5.0
07/21-07/26	**Severe Convective Storm**	Europe	11	**5.8**	3.0
08/08-08/17	**Hawaii Wildfires**	United States	100	**5.5**	3.5
03/31-04/01	**Severe Convective Storm**	United States	37	**5.5**	4.4
All other events			~35,100	**178.0**	84.8
Totals			**~95,000**	**380**	**118**

Approximately a quarter of all economic losses in 2023 were attributed to the disastrous earthquake sequence in Turkey and Syria, which struck the region in February. Widespread impact on property and infrastructure resulted in more than $90 billion in direct damage — making it the costliest natural disaster recorded in both Turkey and Syria, the Middle East and the entire EMEA region in modern history.

At least four other events have crossed the $10 billion-dollar economic damage threshold, with China reporting total flood damage in excess of $30 billion again, after a below-average loss year in 2022. Powerful Hurricane Otis made its devastating landfall at Category 5 intensity near Acapulco in Mexico and made history as the strongest landfalling hurricane in Eastern Pacific. Drought was prominent in North and South America.

While only three severe convective storm events ranked among the top 10 individual economic losses of 2023 and none of them surpassed $10 billion, the peril was responsible for more than $94 billion in combined damage.

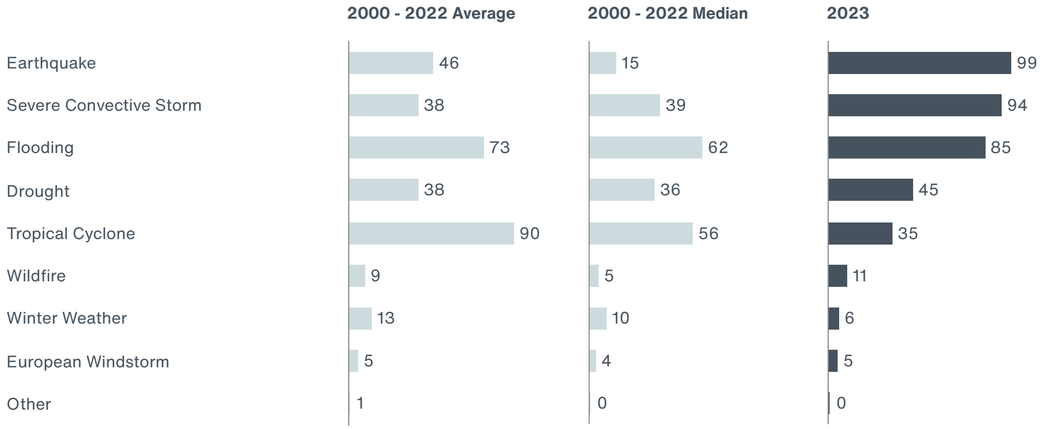
Exhibit 3: Global Economic Losses from Natural Disasters (2023 $B)



Data: Aon Catastrophe Insight

Global economic losses from natural disasters in 2023 were estimated at $380 billion and exceeded the 21st century average ($312 billion) and median ($303 billion) on a price-inflated basis. They were also higher than the decadal mean and median ($342 and $337 billion, respectively). Excluding geophysical disasters, global economic losses were lower than the decadal average and significantly lower than in the record year of 2017 ($588 billion).

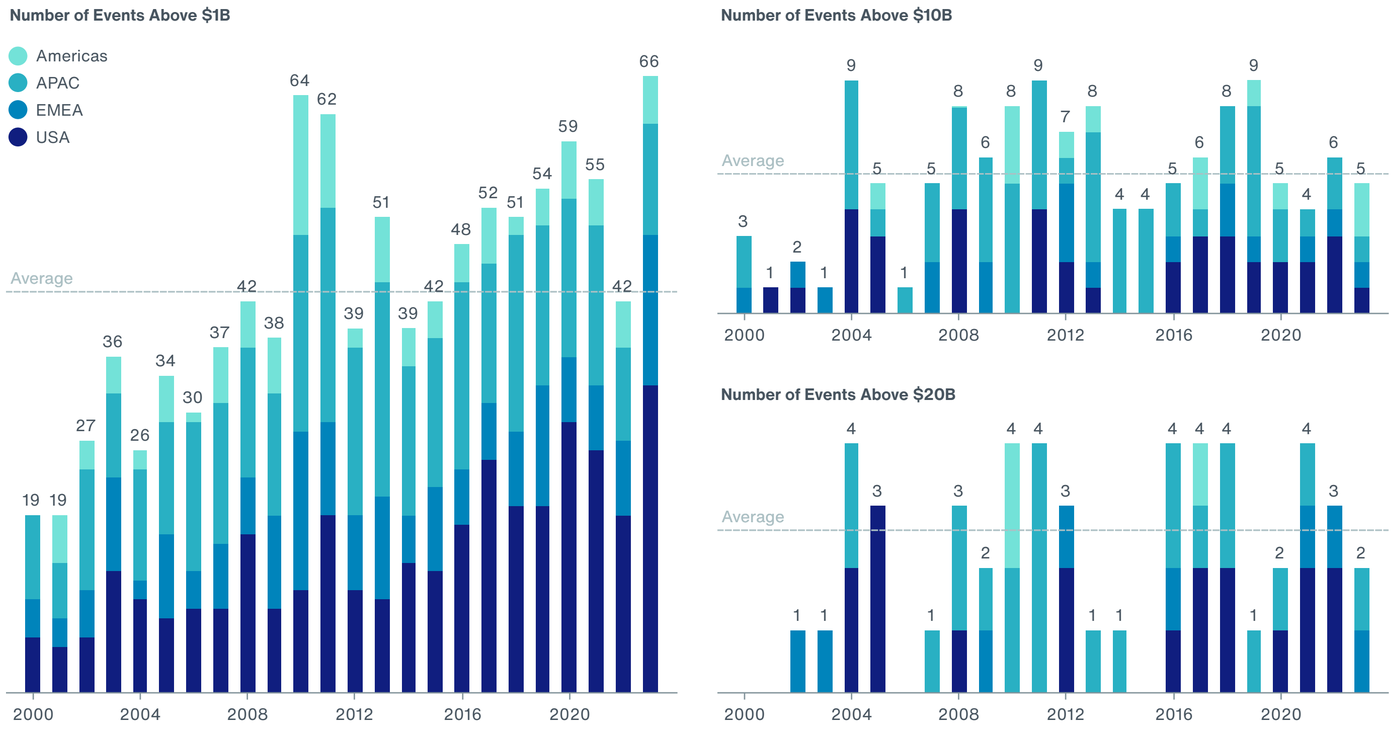
Exhibit 4: Global Economic Losses by Peril (2023 $B)



Data: Aon Catastrophe Insight

Largely driven by the costly sequence in Turkey and Syria, earthquake was the costliest peril of the year, followed by severe convective storms and flooding. All other perils except wildfire generated lower-than-average losses in 2023, with tropical cyclones causing only 39 percent of its average losses.

Exhibit 5: Global Billion-Dollar Economic Loss Events



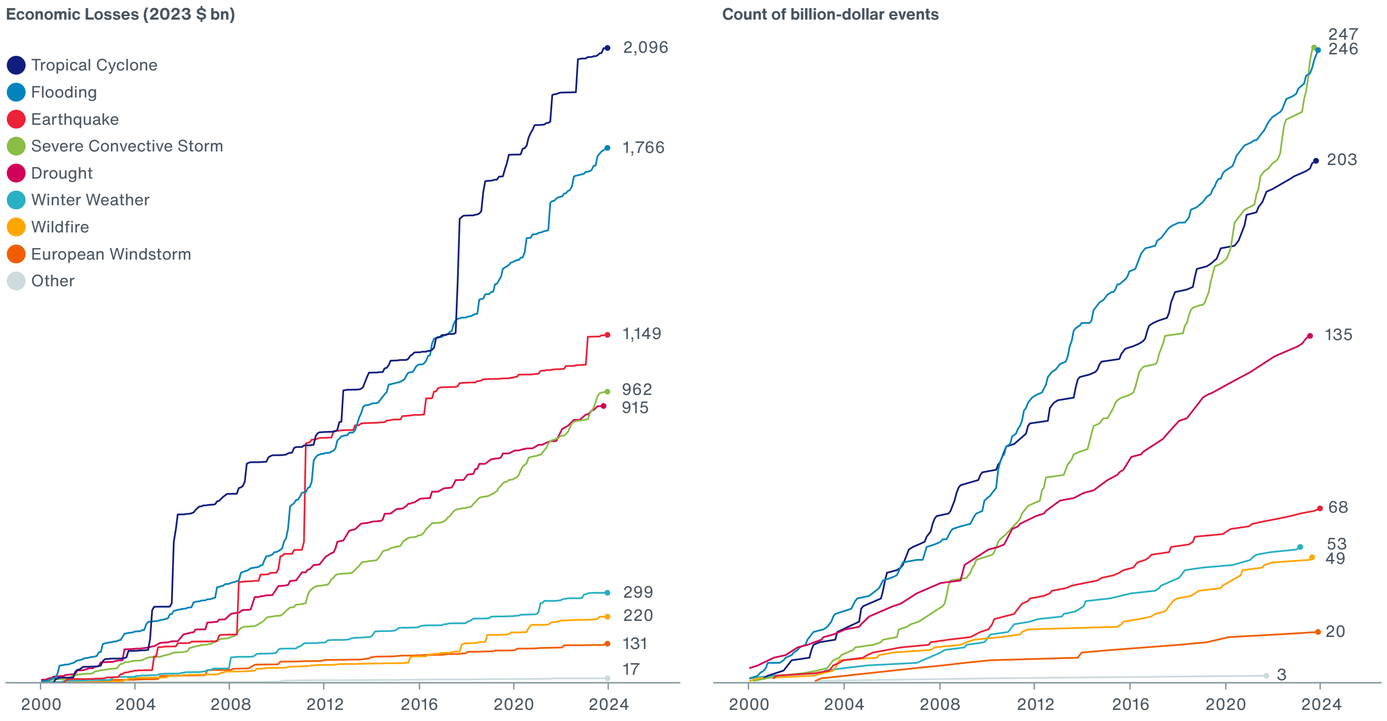
Data: Aon Catastrophe Insight

In 2023, there were at least 66 individual billion-dollar natural disasters, which was well above the average of 43. Half of these events occurred in the United States alone. Please note that for this report, wildfires are treated as individual events. Additionally, cross-regional events, such as Atlantic hurricanes, which caused billion-dollar losses in two regions, are only counted once.

There is undoubtedly a sharp increase in the number of disasters that result in more than $1 billion in economic losses globally on a price-inflated basis. This trend can largely be attributed to the increase of exposed assets.

The increase in the number of these medium-size events is driven by the growing frequency of costly severe convective storms. The upward trend is less apparent when focusing on a higher loss threshold. For example, there have been 52 individual events that resulted in losses above $20 billion in 2023 USD since 2000. While such occurrences remain relatively rare, there has been at least one such event every year since 2016. Natural perils responsible for the highest number of such “mega-disasters” are tropical cyclone (18 since 2000), flooding (12) and earthquake (11).

Exhibit 6: Cumulative Global Economic Losses by Peril



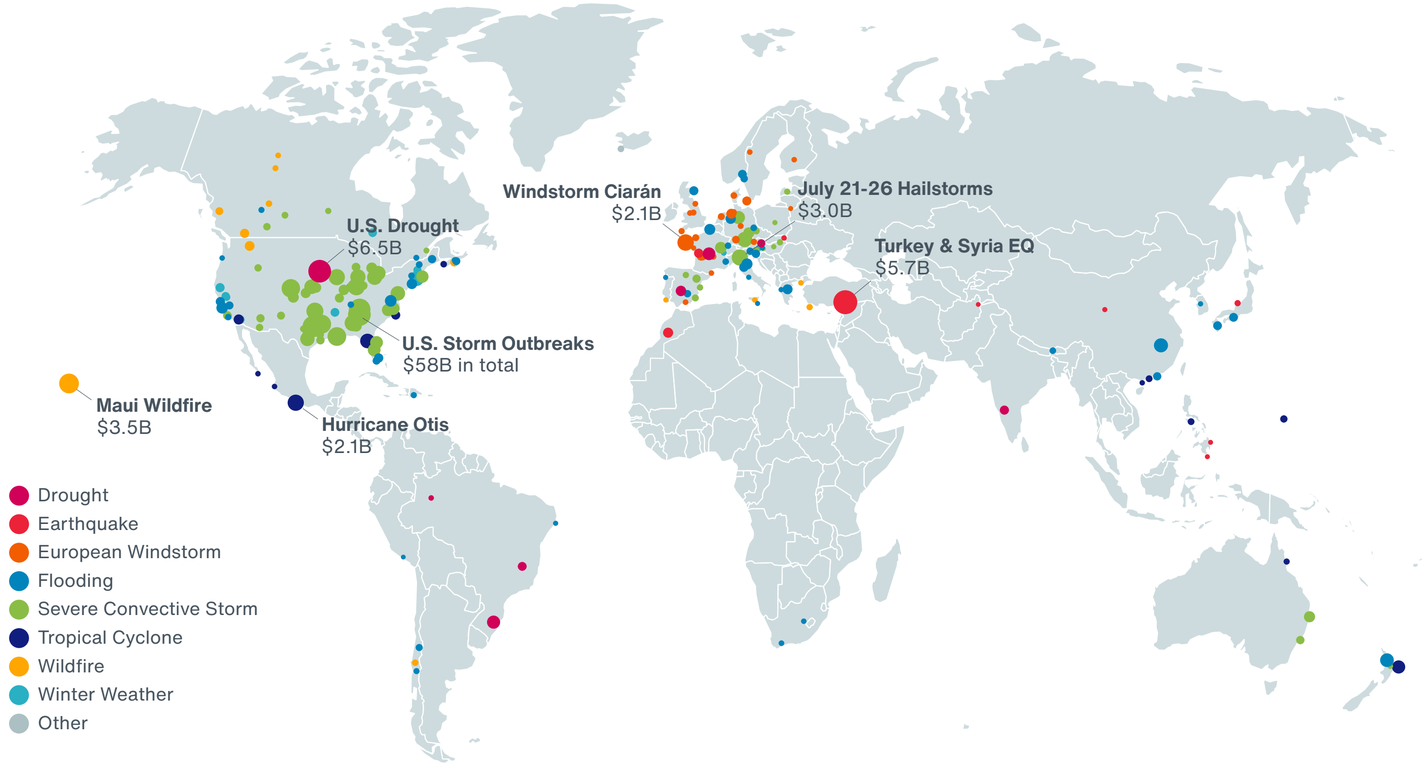
Data: Aon Catastrophe Insight

Tropical cyclone and flooding remained the costliest perils of the 21st century on a cumulative basis. Despite its significant loss potential, earthquake ranked first for only a short period of time in 2011 after a series of costly events. Despite the extreme loss year in 2023, earthquake may lose its third position in the following years due to the accelerating growth of the severe convective storm peril, driven by the aforementioned increasing frequency of medium-size events.

Notably, SCS overtook flooding in terms of the cumulative number of billion-dollar events in 2023. There were at least 28 such SCS events last year — 23 of which occurred in the United States and 5 took place in Europe.

Global Insured Losses Driven by Record-breaking Number of Costly Events

Exhibit 7: Notable 2023 Insured Loss Events



Data: Aon Catastrophe Insight

Global insured losses from natural disasters in 2023 are estimated at $118 billion, well above the short-, medium- and long-term averages.

Only about 31 percent of global economic losses were covered by private or public insurance, which was close to long-term normal. This presents a notable decrease after 2022, when more than 42 percent of total losses were covered and the protection gap was the lowest on record. Many of the significant disasters across the world generated significant uninsured damage, costs of which had to be covered by local governments.

The largest loss of the year can be attributed to the seasonal drought in the United States, with total crop insurance payouts above $6.5 billion. The earthquake sequence in Turkey and Syria came second, but vast majority of the large events were concentrated in North America and Europe. Notably, New Zealand recorded two back-to-back billion-dollar events.

To read more about available reinsurance capital, please read Aon's Reinsurance Market Dynamics Report.

Exhibit 8: Top 10 Global Insured Loss Events in 2023

Date	Event	Location	Deaths	Economic Loss ($ billion)	Insured Loss ($ billion)
01/01-12/31	**U.S. Drought**	United States	N/A	14.0	**6.5**
02/06-02/20	**Turkey and Syria Earthquakes**	Turkey and Syria	59,272	92.4	**5.7**
03/01-03/03	**Severe Convective Storm**	United States	13	6.2	**5.0**
03/31-04/01	**Severe Convective Storm**	United States	37	5.5	**4.4**
06/21-06/26	**Severe Convective Storm**	United States	7	5.3	**4.3**
08/08-08/17	**Hawaii Wildfires**	United States	100	5.5	**3.5**
06/10-06/15	**Severe Convective Storm**	United States	3	3.9	**3.1**
06/15-06/20	**Severe Convective Storm**	United States	5	3.8	**3.0**
07/21-07/26	**Severe Convective Storm**	Europe	11	5.8	**3.0**
05/09-05/14	**Severe Convective Storm**	United States	1	3.6	**2.9**
All other events			~35,600	234.0	**76.6**
Totals			**~95,000**	**380**	**118**

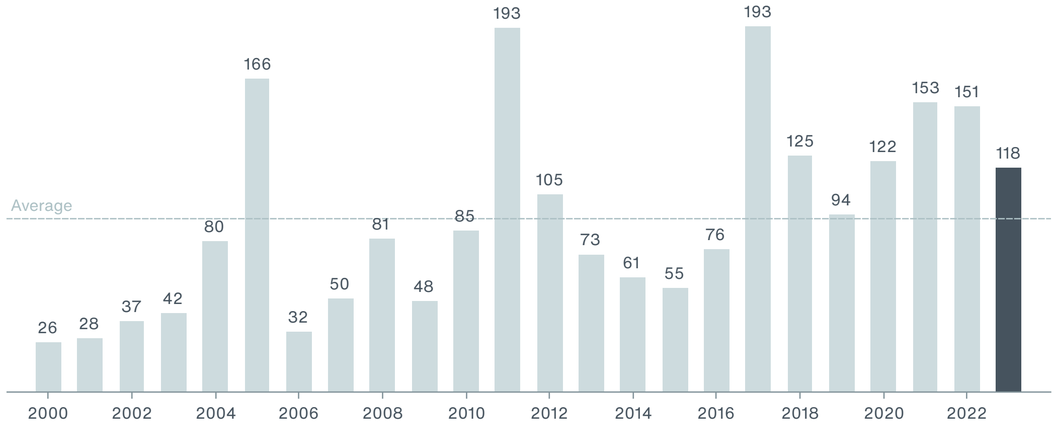
In 2023, no global event resulted in losses to the insurance industry in excess of $10 billion, which happened for the first time since 2016 on a price-inflated basis. Yet the number of medium-sized events, notably those above $1 billion in insured losses, was unprecedented and reached 37, beating the previous record of 30 set in 2020. This was largely driven by the relentless SCS activity in the United States and Europe and is manifested by seven such events in the table of top 10 losses.

However, the costliest disasters from the insurance perspective were the U.S. Drought and also the earthquake sequence in February, which resulted in significant losses to both public and private insurers in Turkey.

The devastating wildfire that impacted Hawaii in August resulted in insured losses of $3.5 billion — making it one of the eight costliest wildfires on record.

Several countries recorded their all-time costliest events, even if they are not featured in this global comparison — Slovenia, Morocco and Greece.

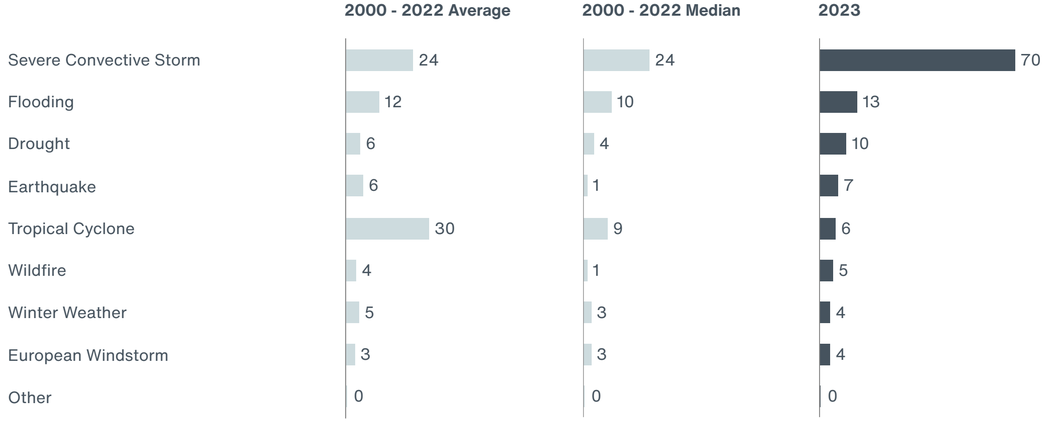
Exhibit 9: Global Insured Losses from Natural Disasters (2023 $B)



Data: Aon Catastrophe Insight

Total insured losses from natural disasters in 2023 reached $118 billion and were well above the 21st century average ($90 billion) and median ($80 billion), yet significantly lower than the average of the period since 2017, which features six consecutive years of above-average losses. It was the fourth time in a row that global losses exceeded $100 billion.

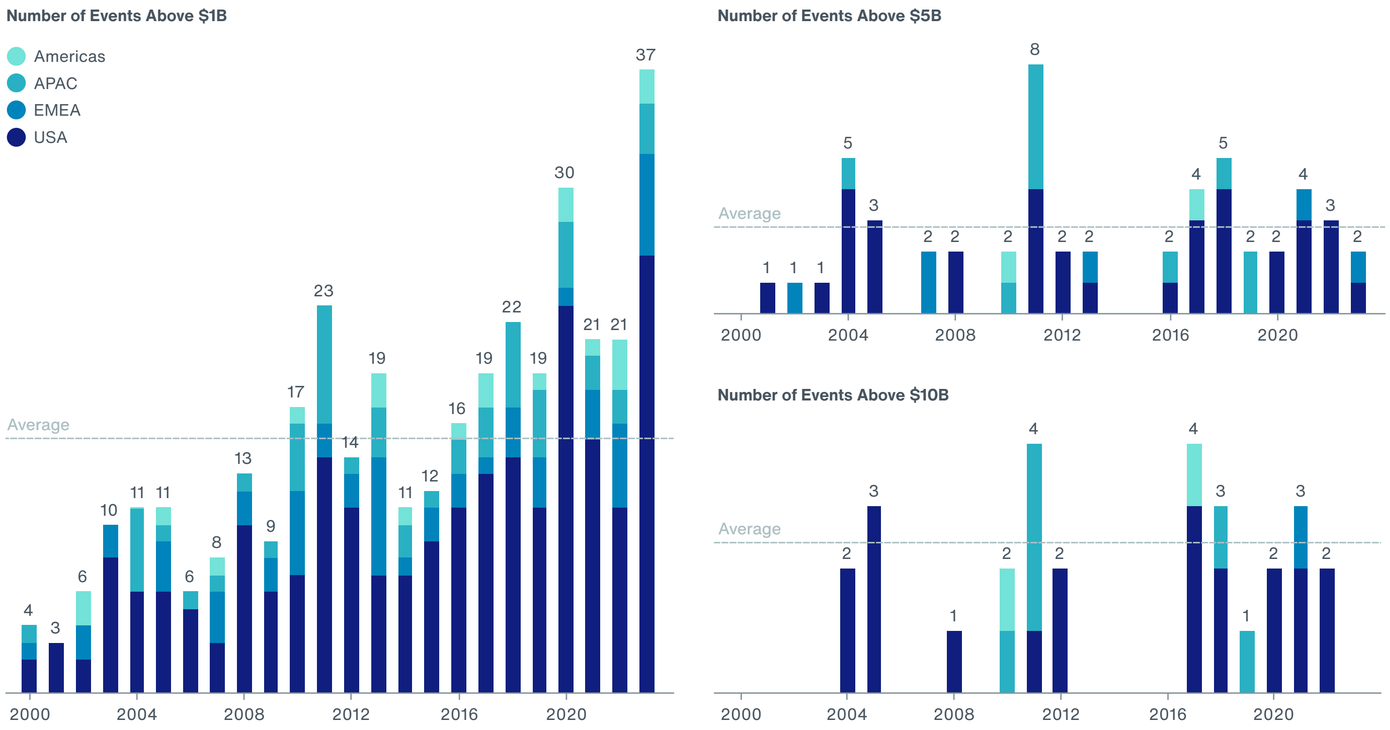
Exhibit 10: Global Insured Losses by Peril (2023 $B)



Data: Aon Catastrophe Insight

Severe convective storm peril dominated in 2023 and accounted for approximately $70 billion of insured losses globally, or 59 percent of losses from all natural disasters. Flooding, drought, earthquake, wildfire and European windstorm were also above their averages.

Exhibit 11: Global Billion-Dollar Insured Loss Events



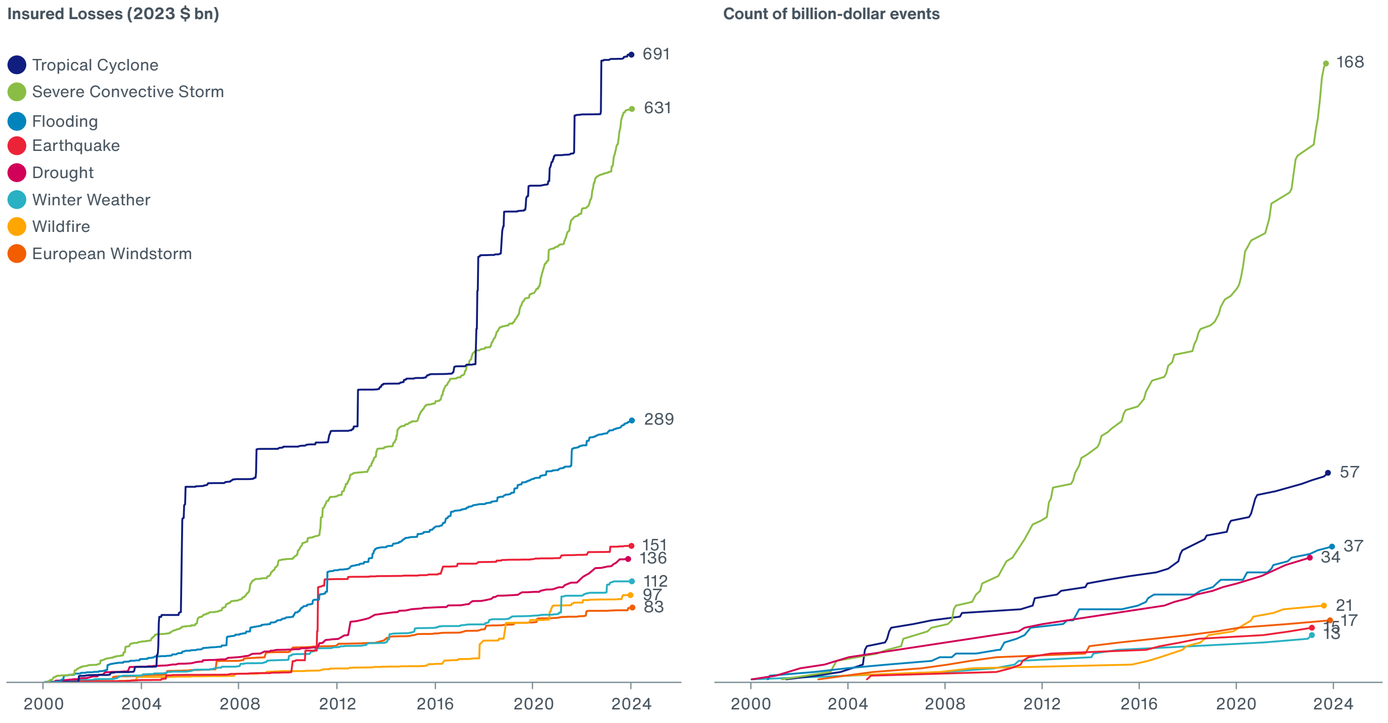
Data: Aon Catastrophe Insight

In 2023, there was an unprecedented number of billion-dollar insured loss events (37), which was well above the average of 14 and the previous record of 30, set in 2020. This was largely driven by 25 such severe convective storm events, of which 21 occurred in the United States. All but one of the global billion-dollar events were weather-related.

On the other hand, the world did not see an individual disaster that would cause insured losses above $10 billion for the first time since 2016. There were 29 such events globally since 2000. The peril most often associated with this level of extreme losses is tropical cyclone with 16 such events, but also earthquake (4), wildfire (2) or winter weather (1). In two years — 2012 and 2022, the United States also recorded crop insurance payouts in excess of $10 billion related to drought.

Additionally, due to continuing inflation throughout 2023, two severe convective storm events now exceed the $10 billion mark on the price-inflated basis: the 2011 Super Tornado Outbreak, and the outbreak that included the Midwest Derecho in 2020.

Exhibit 12: Cumulative Global Insured Losses by Peril

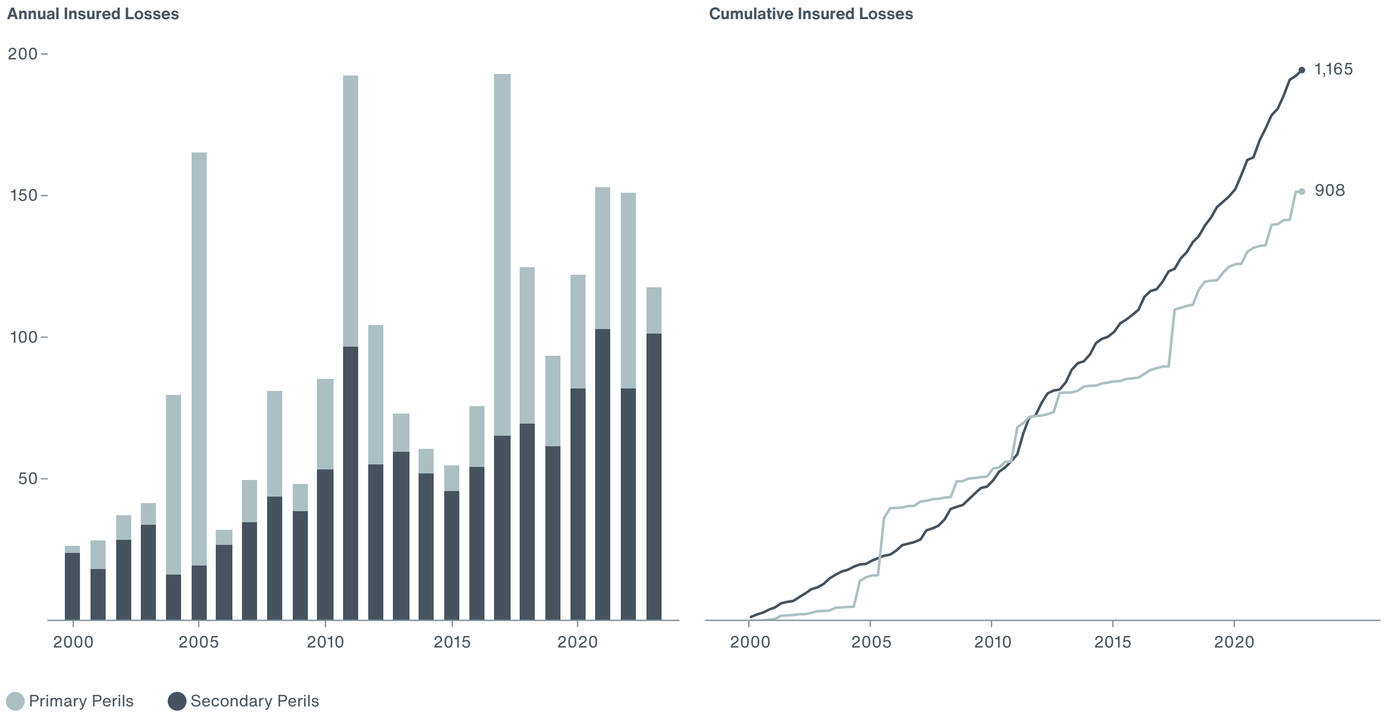


Data: Aon Catastrophe Insight

The gap between tropical cyclone and severe convective storm, as two costliest perils for insurers on a cumulative basis since 2000, narrowed significantly in 2023. This was a result of record-breaking SCS losses and below-average losses from tropical cyclones. It becomes increasingly likely that SCS will assume the first place on the global scale in the following years. This already happened for a short period of time in 2017, before the trio of costly Atlantic hurricanes Harvey, Irma and Maria struck North America and the losses related to tropical cyclones jumped by $116 billion within a period of one month.

The dominance of the severe convective storm peril is clearly shown through the frequency of costly events. The total number of billion-dollar storm events since 2000 now stands at 168, more than the next five perils combined.

Exhibit 13: Global Insured Losses from Primary and Secondary Perils (2023 $B)



Data: Aon Catastrophe Insight

The natural perils traditionally considered as primary or peak (Tropical Cyclone, Earthquake and European Windstorm) have a potential to result in catastrophic, costliest individual events. However, so-called “secondary” perils outpaced their cumulative costs in the 21st century by a large margin and in 2023, primary perils only accounted for about 14 percent of global losses.

Global Fatalities at Their Highest Since 2010

Exhibit 14: Top 10 Human Fatality Events in 2023

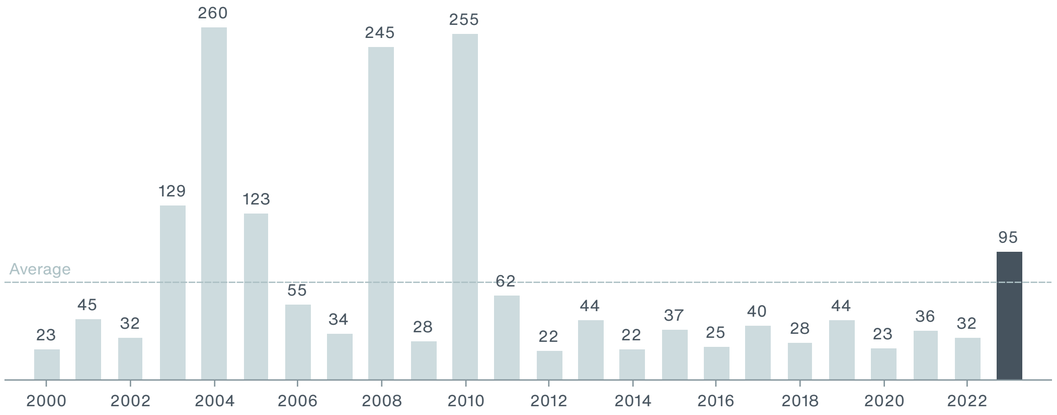
Date	Event	Location	Deaths	Economic Loss ($ billion)
02/06-02/20	**Turkey and Syria Earthquakes**	Turkey and Syria	**59,272**	92.4
08/13-08/27	**Heatwave**	Europe	**8,339**	N/A
07/10-07/30	**Cerberus Heatwave**	Southern and Southeastern Europe	**5,949**	N/A
09/04-09/12	**Storm Daniel**	Greece, Bulgaria, Libya, Turkey	**4,730**	4.3
09/08	**High Atlas Earthquake**	Morocco	**2,946**	4.0
04/01-12/31	**India Seasonal Floods**	India	**2,653**	0.3
10/07-10/15	**Western Afghanistan Earthquakes**	Afghanistan	**1,480**	0.1
02/20-03/15	**Cyclone Freddy**	Southern Africa	**1,434**	0.7
09/03-09/08	**Heatwave**	Western Europe	**1,306**	N/A
05/02-05/05	**Eastern DRC Flooding**	Democratic Republic of the Congo	**470**	0.1
All other events			**~6,400**	278.1
Totals			**~95,000**	**380**

At least 95,000 people sadly lost their lives due to global natural catastrophe events in 2023, which was well below the 21st century average (71,430) and median (38,840). Roughly 62 percent of these fatalities can be directly attributed to a single event — the earthquake sequence in Turkey and Syria in February. This was the deadliest global disaster since the devastating tremor in Haiti in 2010. The human toll of this event was also exacerbated by a high number of injuries, which was estimated at more than 120,000.

Heatwaves also resulted in a large number of excess deaths worldwide in 2023. In particular, parts of Western and Southern Europe were hit by multiple waves of extreme temperatures from July to September, which resulted in at least 15,000 deaths.

Despite an above-average year, the number of human casualties has shown a long-term decrease in recent decades. This was likely thanks to multiple factors, including the improvements in forecasting, evacuation planning and strategies, increased public awareness and better building practices.

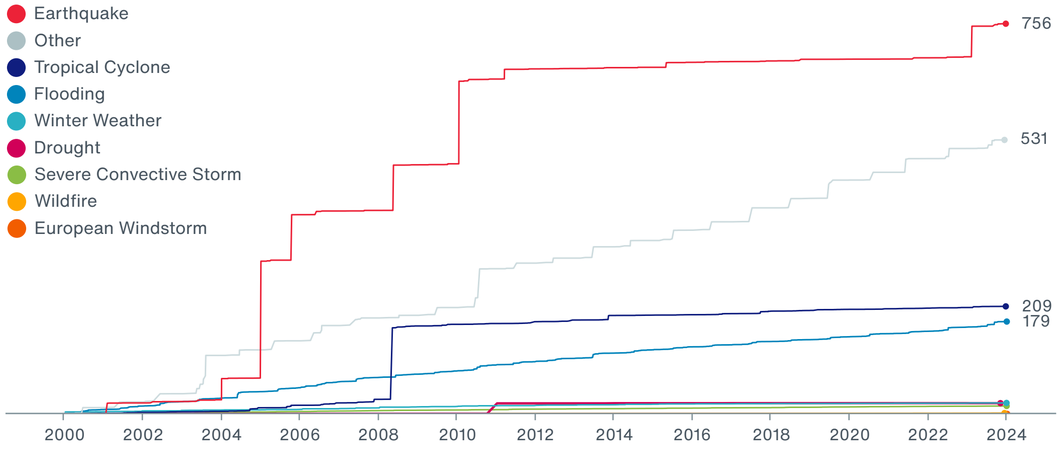
Exhibit 15: Global Natural Disaster Fatalities (thousands)



Data: Aon Catastrophe Insight

The number of global fatalities in 2023 was higher than average, yet significantly lower than in the extreme years of 2004, 2008 or 2010. Focusing on weather-related disasters only, 2023 was below average and close to the 21st century median.

Exhibit 16: Cumulative Global Fatalities by Peril (thousands)

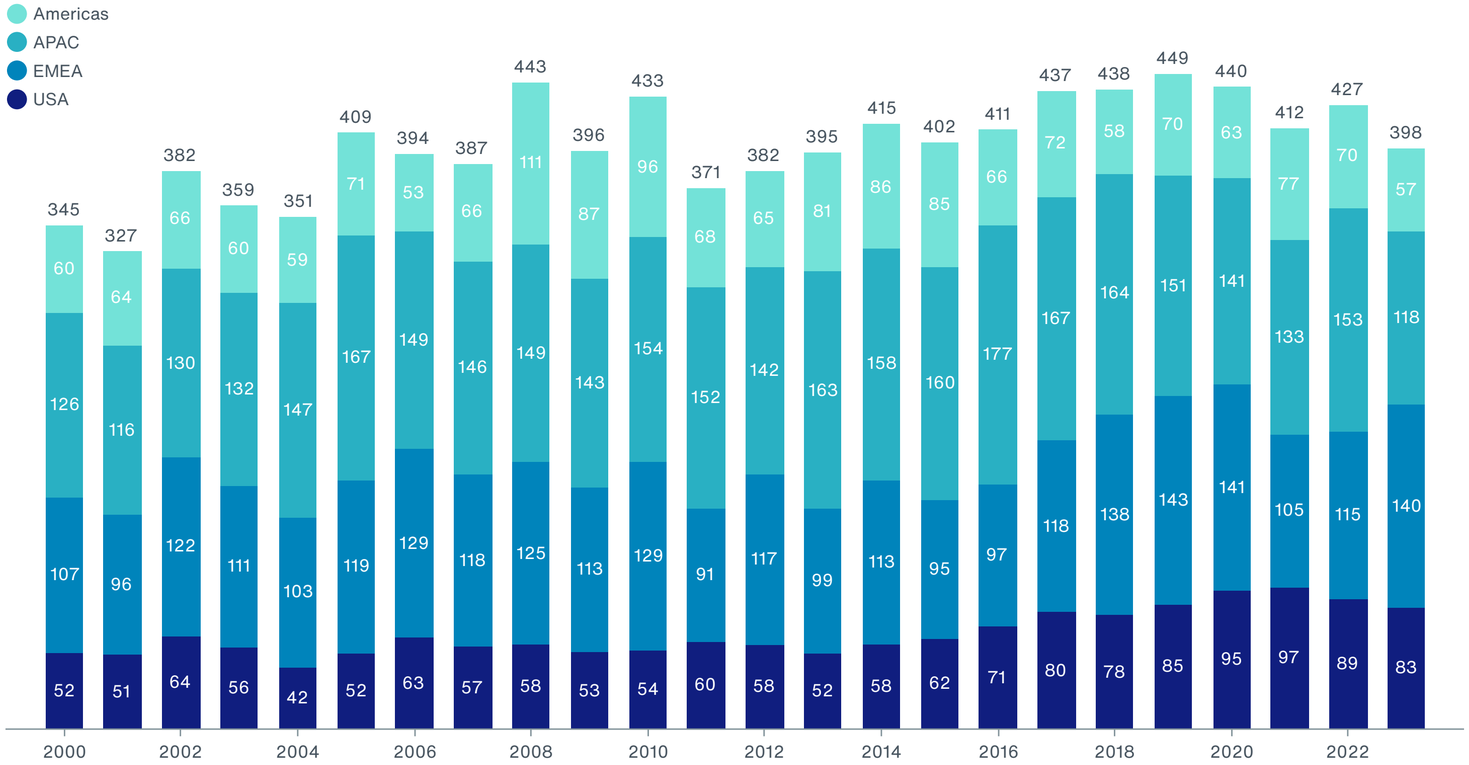


Data: Aon Catastrophe Insight

The cumulative death toll from earthquakes, which currently runs at more than 756,000 since 2000, is largely driven by a small number of catastrophic events. On the other hand, heatwaves emerged as the second most significant cause of death due to a steady increase over the last decades.

Natural Disasters Defined: Number of Events on the Rise

Exhibit 17: Number of Relevant Natural Disaster Events



Data: Aon Catastrophe Insight

An event must meet at least one of the following criteria to be classified as a natural disaster in Aon's Catastrophe Insight Database:

- Economic Loss: $50 million
- Insured Loss: $25 million
- Fatalities: 10
- Injured: 50
- Structures Damaged or Filed Claims: 2,000

Based on the criteria above, there were at least 398 individual natural disasters in 2023, which was slightly below both the average (400) and median (402) since 2000. All natural disasters meeting the criteria are listed in Appendix A: 2023 Global Disasters.

Additional 2023 events may be added later due to further research and data updates. As typically anticipated given the highest frequency of SCS, flood and tropical cyclones, the highest number of disaster events occurred during the second (100) and third (113) quarters.

How Insurers Can Capture Climate Opportunities

The insurance industry plays a crucial role in helping individuals, businesses and governments adapt to, and mitigate the impact of, climate change and enabling transition from brown to green energy. During this transition, there are growth opportunities and risks.

Analysis from Aon's Strategy and Technology Group (STG) has identified more than $20 billion in potential premium growth by 2030 related to environmental megatrends, i.e., powerful transformative trends that are shaping the future landscape and driving potential demand for insurance.

Of the 80 transformative trends identified by STG, around a quarter relate to environmental factors, including climate change adaptation and mitigation and the transition to green energy and biodiversity.

Insurance for resilient infrastructure development, electrification, carbon capture and storage, and the decommissioning of carbon intensive assets combined could generate gross written premiums of between $8 billion and $25 billion. These transformative trends present immediate growth potential and can be addressed today — although carbon capture and storage would require some additional innovation or investment in capabilities.

Unlocking Energy Transition Investment

The energy transition is attracting huge investment, from the expansion of renewables to emerging technologies. Annual clean energy investment worldwide will need to more than triple by 2030 to around $4 trillion to reach net-zero emissions by 2050[1].

While the need to expand sustainable energy capacity is clear, investments do not always flow as smoothly and as quickly as they could. For example, concerns for natural catastrophe exposures, proto-type technologies and political risks have held back investment in some solar and offshore wind projects. Insurance can, however, address a range of political, technical, credit and operational challenges that would otherwise deter investment or increase the costs of financing renewable projects.

Insurance in the renewable space has yet to fully meet its potential, in part due to uncertainties over catastrophe exposures and models. Aon STG has been working with insurers to assess market opportunities in the renewable space and attract much-needed capacity. However, there is much more that could be done collectively to bring more insurers into this space and begin to fill the growing protection gap.

Helping Homeowners Adapt to Climate Extremes

While the renewable energy market has already attracted insurers' attention and capital, there is also significant growth potential from helping individuals, businesses and governments manage the risks of a more volatile climate. However, when it comes to homogenous lines of business such as homeowners' insurance, the industry has yet to fully grapple with climate change.

Property natural catastrophe insurance is an area where the insurance industry can really make a difference. By being pro-active, insurers can help insureds reduce exposure, while at the same time ensuring a sustainable flow of premium for the industry. For example, some properties in California struggle to buy affordable insurance or even cover at any price due to wildfire risk. However, carriers can help homeowners better understand the risks and where to best invest in loss prevention and mitigation.

Insurers are well positioned to guide customers through the transition. We have the knowledge and experience of the risks that are coming our way. We just need to accelerate our efforts, focus on what we are good at as an industry, and be more tenacious.

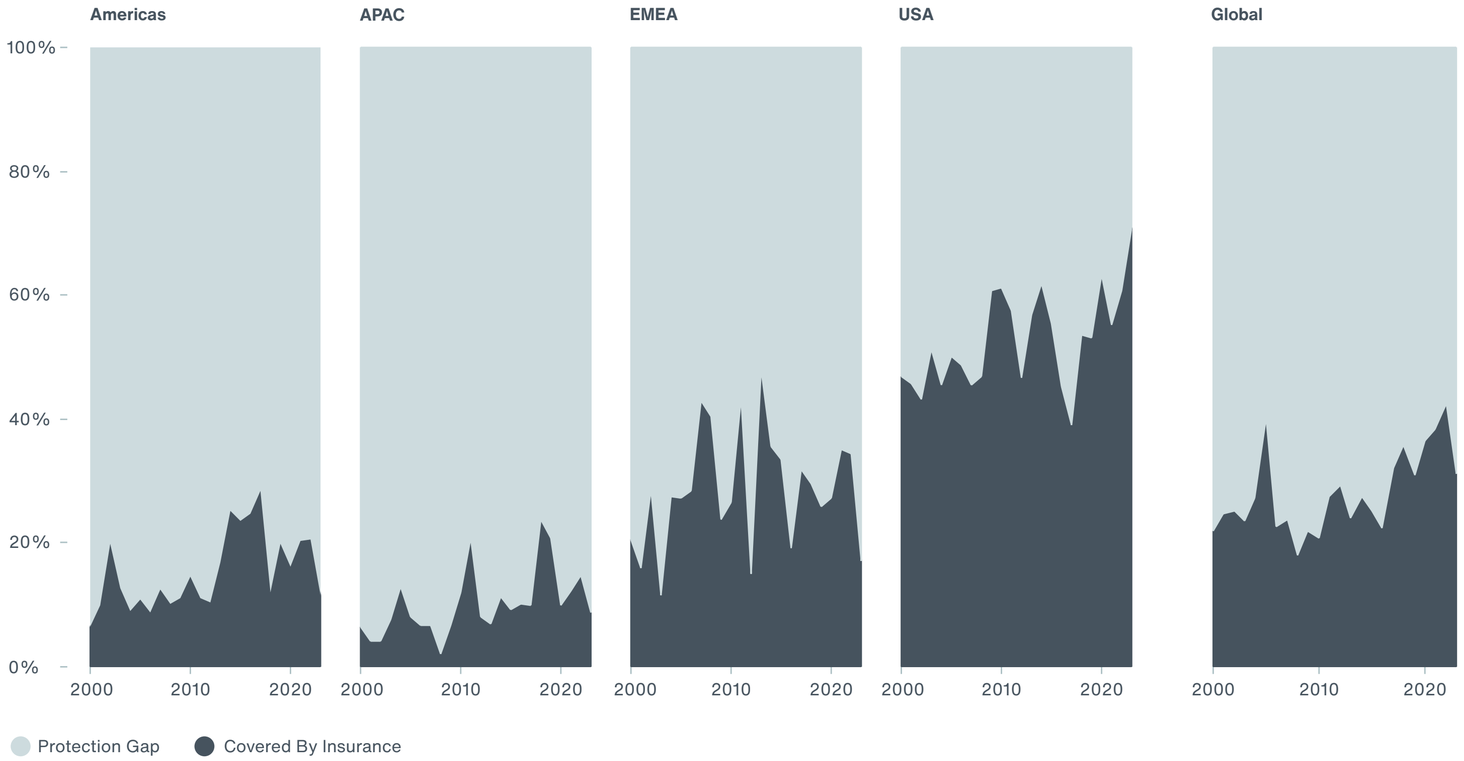
Liz Henderson
Global Head of Climate Risk Advisory, Aon

Exploring the Global and Regional Protection Gap

Using the difference between total damage and losses covered by insurers as a critical reference point for understanding opportunities.

Regional and Peril Analysis

Exhibit 18: Protection Gap by Region

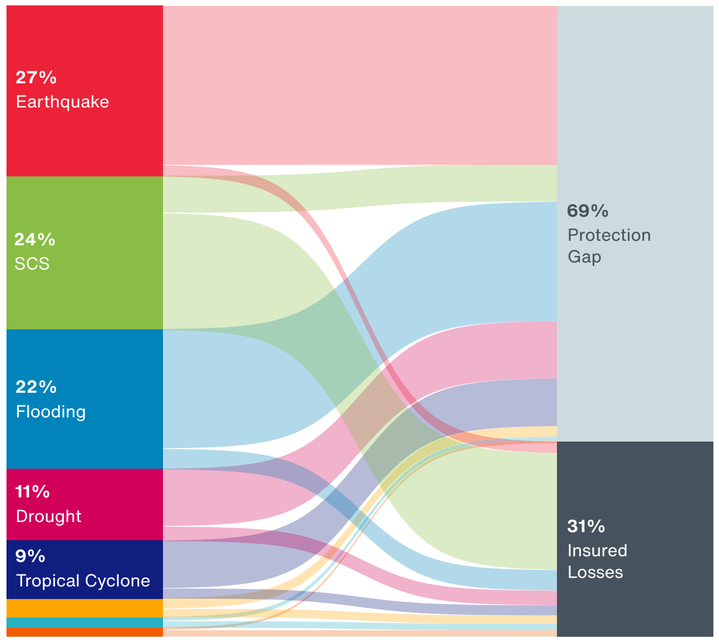


Data: Aon Catastrophe Insight

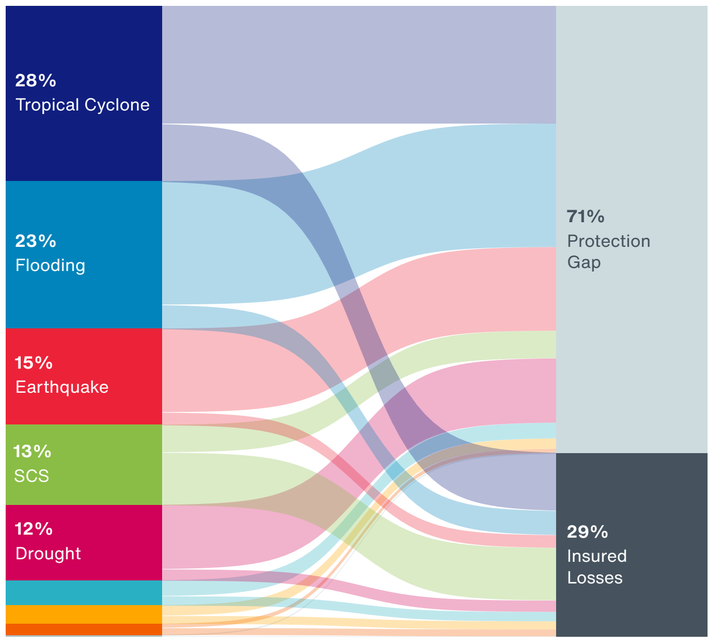
While 2022 saw the lowest protection gap on record, as major events occurred in mature markets, the amount of disaster losses covered by insurers in 2023 represented 31 percent of total economic losses and was close to average (28 percent). However, significant regional differences remained. In the United States, most losses were covered as is typically the case, majority of losses in other regions went uninsured. This was the case in EMEA, given earthquakes in Turkey, Syria and Morocco, as well as flooding events in Italy, Greece and Libya. All these countries have a relatively low flood insurance take-up.

Exhibit 19: Protection Gap by Peril in 2023 and on Average since 2000

How economic losses in 2023 translated to un/insured losses?



What is the average distribution (since 2000)?

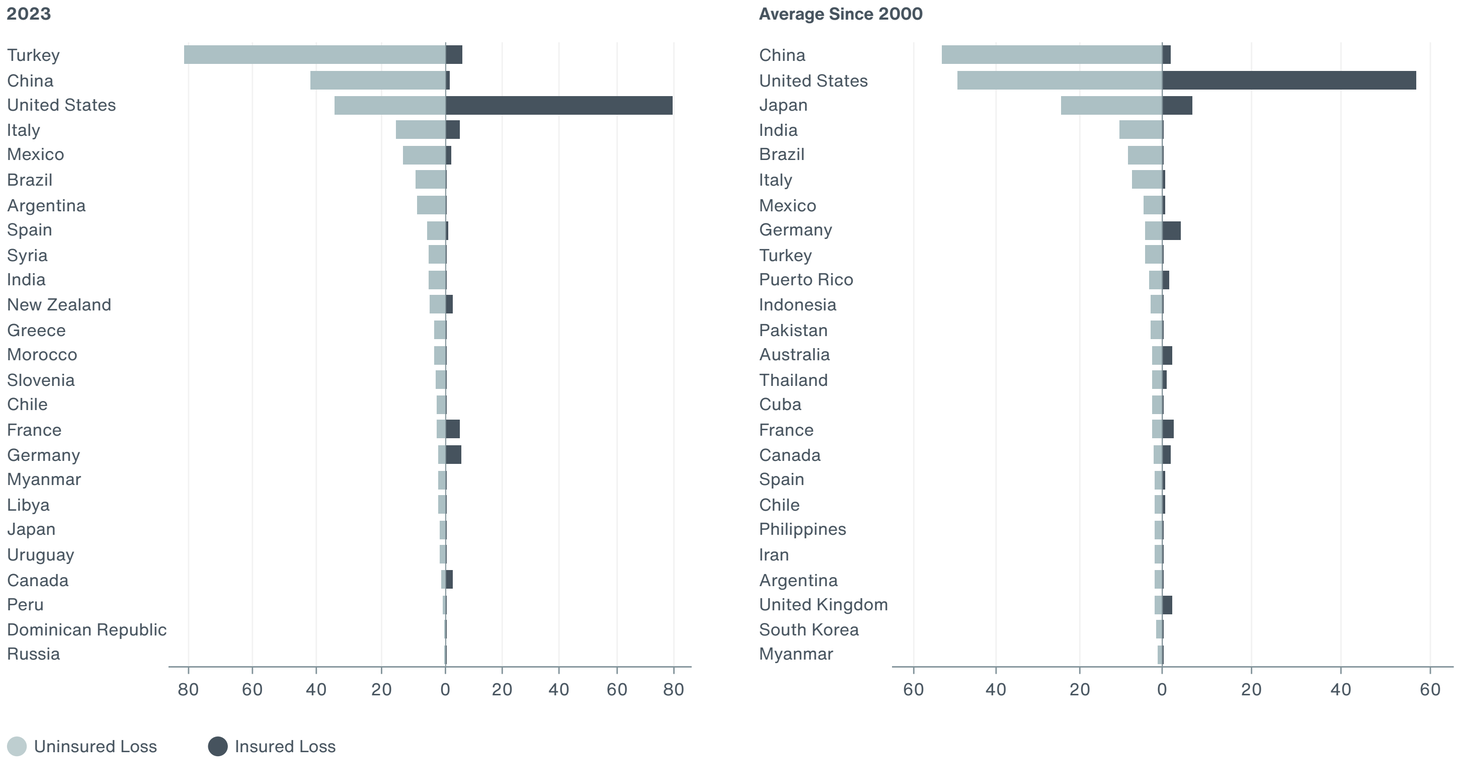


Wildfire Winter Weather European Windstorm

Data: Aon Catastrophe Insight

The protection gap is a critical reference point for the insurance industry, financial markets and governments, as it illustrates the financial vulnerability of communities and provides the opportunity to identify the need for new solutions. In addition to region-specific protection gaps, there are key differences between perils.
The visualizations on the left show what part of the economic losses for a given peril translates to the insured losses and what part is uninsured. This is shown for 2023 and for the average since 2000.

Exhibit 20: Uninsured and Insured Losses by Country (2023 $B)



Data: Aon Catastrophe Insight

The country-by-country comparison offers a different perspective; the highest insured losses are consistently found in the United States and reached $80 billion in 2023. However, a large portion of disaster losses remains uninsured even in this market.

The largest uninsured losses in 2023 were recorded in Turkey and China. Italy and Mexico experienced around $15 billion of uncovered losses, followed by Brazil and Argentina with less than $10 billion.

On average, the largest volume of losses that goes uninsured results from natural disasters in China with $54 billion of uninsured losses per year on average and less than $2 billion typically insured.

How Parametric Insurance Can Help Close the Protection Gap

With a 69 percent protection gap in 2023, many risk buyers are challenged to find adequate coverage for their natural catastrophe-prone exposures. Leaders must be prepared to make better decisions when faced with natural catastrophes, starting with the use of parametric insurance.

Parametric insurance is an innovative, transformative and straight-forward solution, well-suited for "grey swan" catastrophic events, including floods, earthquakes, named windstorms, hailstorms, tornadoes and wildfires, among other perils. That includes secondary perils, such as non-damage business interruption, loss of attraction, loss of ingress/egress, and sub-limited or excluded coverage.

In 2023, multiple parametric insurance payouts helped local governments to overcome impacts of natural disasters. For example, the CCRIF (Caribbean Catastrophic Risk Insurance Facility) facilitated $2.9 million for Antigua and Barbuda and $0.5 million for the British Virgin Islands in response to the Tropical Storm Philippe; plus $1.5 million for St. Kitts and Nevis in response to Hurricane Tammy.

Parametric insurance's flexibility also makes it well-suited for other exogenous events. Capacity providers can underwrite parametric policies that address exposures related to a drop in tourism volume, pandemics, cloud service outages and other situations where there is a clear impact that can be described by independent data.

Known unknowns like grey swan natural catastrophe events are where parametric shines. Parametric solutions are:

Independent: Triggering parameters are measured and reported by a third party. Risk managers can clearly define events that will and will not result in paid claims, as well as the sum of those claims.

Fast: Because there is a clear event trigger, claim settlement is quicker and more transparent. Coverage is usually confirmed within days and funds arrive within weeks — avoiding a complex loss adjustment process.

Flexible: Any financial loss ensuing from a triggering event can be an indemnifiable expense under parametric insurance.

Further, parametric insurance does not pose the same capacity challenges as traditional insurance, making it ideal for businesses that are unable to secure traditional cover.

Modern data allows for added precision with it comes to determining parametric triggers. As it improves over time, parametric cover will become more efficient and economic as a complement to traditional property coverage — especially where capacity and pricing issues continue in traditional indemnity markets. This will enable businesses to manage risk more effectively, and ultimately achieve improved operational resilience.

Michael Gruetzmacher
Head of Alternative Risk Transfer and Innovation, North America, Aon

Benjamin Miliauskas
Treaty Broker, Australia and New Zealand, Aon

Alex Davies
Director, Construction, Power and Infrastructure, Asia, Aon

2023 Regional Catastrophe Review

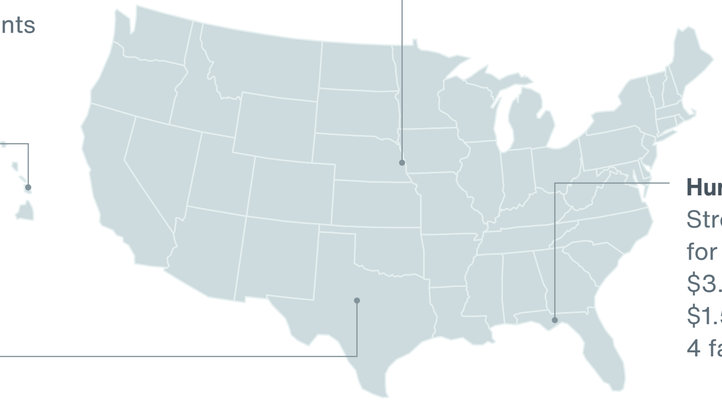
A look at the most significant natural disasters in the U.S., the Americas (non-U.S.), EMEA and APAC regions.

United States

Severe Convective Storm Outbreaks
Record-setting year with
21 billion-dollar insured loss events
$73B economic loss,
$58B insured loss

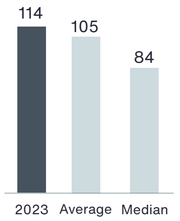
Lahaina Wildfire
Deadliest U.S. wildfire
in over a century
$5.5B economic loss,
$3.5B insured loss,
100 fatalities

Intense Drought
Prolonged drought conditions
throughout 2023
$14B economic loss,
$6.5B insured loss

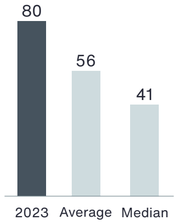


Hurricane Idalia
Strongest hurricane on record
for Florida Big Bend region
$3.5B economic loss,
$1.5B insured loss,
4 fatalities

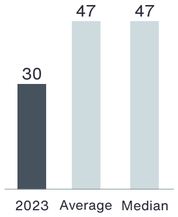
Economic Losses (2023 $ billion)



Insured Losses (2023 $ billion)



Protection Gap (%)

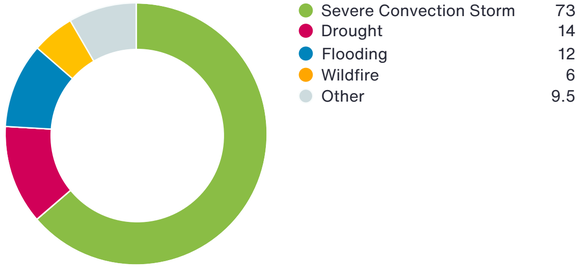


30%
of global
economic losses

67%
of global
insured losses

70%
of losses covered
by insurance

Economic Losses (2023 $ billion)



31 days
Consecutive days of 110 °F (43 °C) or greater
in Phoenix, AZ, in June-July 2023, a new record

-108 °F (-78 °C)
Coldest wind chill ever measured in U.S. history
at Mount Washington, NH on February 3

766
Number of filtered Storm Prediction Center storm reports
on August 7, the highest daily number for 2023

5.25 in (13.3 cm)
New Colorado state record for hailstone diameter;
measured on August 8 in Yuma County

In the United States, economic losses from natural disasters in 2023 were estimated at $114 billion, slightly above the long-term mean ($105 billion) and notably above the median since 2000 ($84 billion).

Public and private insurers covered approximately $80 billion, which was more than 40 percent above the average and 95 percent above the median.

In record-setting fashion, SCS events contributed a remarkable portion of this year's financial toll. The peril generated nearly $58 billion in total insured losses and $73 billion in total economic losses. With these loss estimates, 2023 is now, by far, the costliest year for SCS in United States history. In fact, compared to the next costliest year in 2020, it's $14 billion higher in terms of insured losses. Among the astonishing 23 billion-dollar SCS events, the costliest event of the year was the outbreak on March 1-3. This event resulted in total economic losses of $6.2 billion and insured losses of $5 billion.

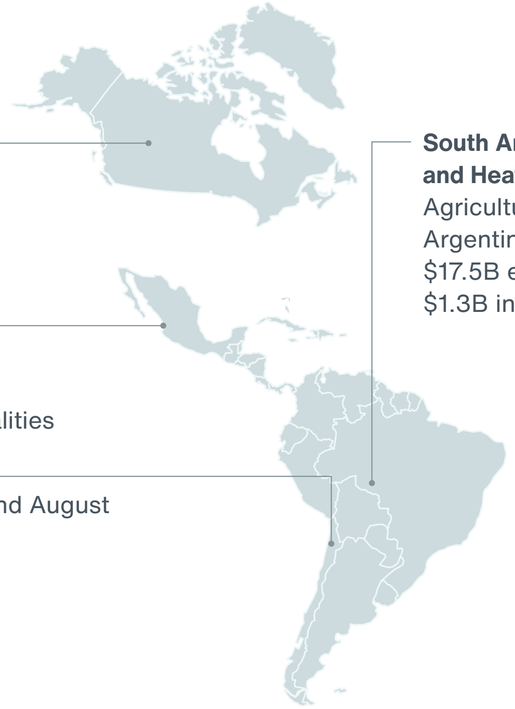
The Lahaina wildfire in Maui County made history as the worst natural disaster in Hawaii since statehood. The devastating fire burned down most of the town and killed 100 people. With $5.5 billion in economic losses and $3.5 billion in insured losses, this event demonstrates the danger wildfires present despite an overall mild wildfire season for the United States.

Economic and insured losses from tropical cyclones in 2023 were among the lowest over the last decade. Most losses came from just two tropical cyclones. Hurricane Idalia, the first Category 4 hurricane to impact Florida's Big Bend region, made landfall at Category 3 intensity and caused widespread flooding damage across much of the southeast United States. Despite $3.5 billion in economic losses, much more severe potential impacts were not realized given the storm's landfall in rural Florida. The other significant tropical cyclone of 2023, Hurricane Hilary, brought record rainfall to much of the western United States. As only the fourth tropical storm on record to affect California, Hilary generated economic losses below $1 billion.

The central United States experienced persistent, severe drought conditions, which drove the annual nationwide economic losses up to $14 billion. Crop insurance payouts were among the highest in the last decade, yet significantly lower than those experienced in 2022.

Flood-related economic and insured losses in 2023 were near the long-term average. Losses were concentrated mainly along the Atlantic and Pacific Coastal states due to multiple, prolonged heavy rainfall events.

Americas (non-U.S.)



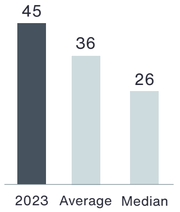
Canada Wildfires
Largest fire extent on record
Costliest event in Kelowna, BC
$465M economic loss,
$310M insured loss

Hurricane Otis
Strongest Pacific landfall on record
Destructive impact in Acapulco, Mexico
$15.3B economic and $2.1B insured loss, 52 fatalities

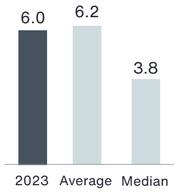
Chile Floods
Widespread flooding in central regions in June and August
$1.9B total economic loss, $120M insured loss

South America Drought and Heatwaves
Agricultural losses in Brazil, Argentina and elsewhere
$17.5B economic loss,
$1.3B insured loss

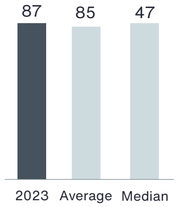
Economic Losses (2023 $ billion)



Insured Losses (2023 $ billion)



Protection Gap (%)

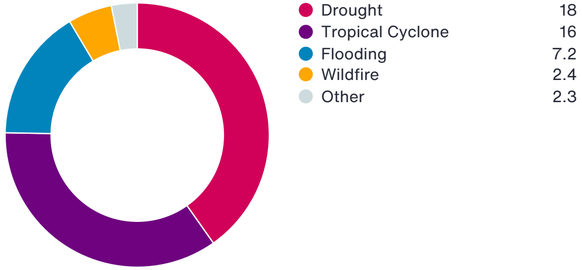


12%
of global economic losses

5%
of global insured losses

13%
of losses covered by insurance

Economic Losses (2023 $ billion)



205 mph (330 kph)
Preliminary peak wind gust measured from Hurricane Otis in Acapulco, Mexico

12.7 m (41.7 ft)
The lowest minimum water level of the Rio Negro in Manaus, Brazil, since 1902

45.7M acres (18.5M hectares)
Approximate area burned by wildfires in Canada in 2023

12 days
Record-breaking number of consecutive days with maximum temperatures exceeding the threshold value for a heatwave 32.3 °C (90.1 °F) in Buenos Aires, Argentina

Total economic losses from natural disasters in the Americas (non-U.S.) were roughly $45 billion, of which public and private insurance entities covered $6 billion.

Economic losses were 27 percent higher than the 21st century average ($36 billion), yet this statistic is skewed by extreme loss years of 2010 and 2017. The losses were nearly 80 percent higher than the median of the same period ($26 billion). Insured losses were comparable to the long-term mean, but significantly higher than the median ($3.8 billion).

Hurricane Otis was the costliest individual event of the year from both economic and insured loss perspective. It struck Acapulco in Mexico in October and resulted in insurance payouts exceeding $2 billion due to widespread damage in the city, and notably to commercial property.

Drought conditions remained in place in several regions of South America throughout the year. Most notably, parts of Brazil, Argentina, Uruguay and Paraguay in the La Plata basin suffered from drought impacts that started in late 2022 and continued into the first quarter of 2023.

However, as El Niño conditions developed, notable flooding events were also recorded. Chile experienced two significant flooding episodes in June and in August, with nearly $2 billion in total estimated economic losses and notable insurance payouts. Yet central and southern parts of the country also suffered from extensive wildfires earlier in the year in February and March with estimated damage of approximately $900 million.

Canada suffered from a record-breaking wildfire season in terms of the total fire extent, as approximately 18 million hectares (45 million acres) of land was burned. However, only a few events resulted in significant property losses. Notably, parts of Kelowna in British Columbia were affected by a wildfire, marking the costliest event of the year for the country.

Several SCS events, related to larger outbreaks in the United States, affected parts of Canada. However, none of these events reached proportions of major events seen in recent years, for example the Southern Canada Derecho in May 2022. Notable flooding events included the Nova Scotia event in July.

EMEA (Europe, Middle East and Africa)

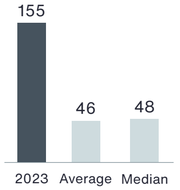
Hailstorms and Floods in Italy
Total annual insured losses exceeding €4.5B ($4.9B)
By far the highest weather-related losses on record

Windstorm Ciarán
The costliest windstorm in France since Xynthia (2010)
Total insured losses in Europe at €1.9B ($2.1B)

Turkey and Syria Earthquakes
The costliest and deadliest event ever recorded in EMEA
$92.4B economic loss, $5.7B insured loss, 59,272 fatalities

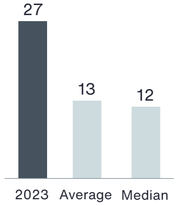
Cyclone Freddy
The longest-lasting tropical cyclone ever recorded worldwide
1,434 fatalities across Southern Africa

Economic Losses (2023 $ billion)



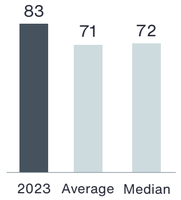
41%
of global economic losses

Insured Losses (2023 $ billion)



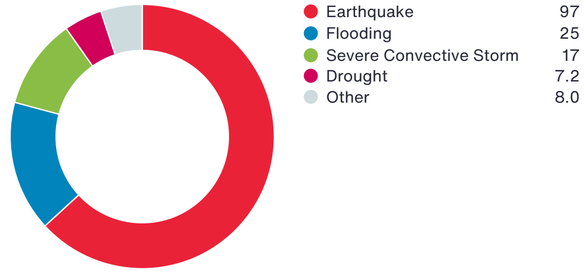
23%
of global insured losses

Protection Gap (%)



17%
of losses covered by insurance

Economic Losses (2023 $ billion)



1.5M hectares (3.7M acres)
Agricultural area affected by severe drought in Spain in Q3. The event prompted the highest agricultural insurance payouts on record.

19 cm (7.5 in)
Diameter of the largest hailstone ever recorded in Europe (found in Italy on July 24)

5
Number of countries that broke their all-time temperature records: Albania, Vatican City, Turkey, Morocco and Chad

17 days
Greece was hit by an exceptionally long heatwave with temperatures exceeding 45 °C (113 °F) between July 22 and August 8.

Total economic losses from natural catastrophes in the EMEA region in 2023 exceeded $150 billion and were the highest on record. This was significantly above the average since 2000 ($46 billion), and nearly three times higher than in the previous year ($57 billion).

This exceptional total was largely driven by the earthquake that devastated much of southeastern Turkey and northern Syria in February. The disaster resulted in total economic losses of around $92 billion. It was one of the costliest earthquakes on record globally, with other top events including Great Tohoku (2011), Sichuan (2008), and Great Hansin (1995) in APAC, as well as the Northridge Earthquake (1994) in the United States.

Insurers covered $27 billion; that was only 17 percent of total economic losses. The total was slightly above the long-term average ($13 billion) and median ($12 billion). The earthquake sequence in February was also the most significant event for the insurance industry in EMEA, as public and private insurance payouts reached $5.7 billion.

The region experienced several significant flooding events. Extensive floods in Emilia-Romagna region in Italy caused widespread economic damage of roughly $9.8 billion. Another significant event was Storm Daniel, which hit Greece and Bulgaria in September and later continued to cause destructive flash flooding event in Derna, Libya and killing more than 2,000 people.

Slovenia recorded the costliest natural disaster in its modern history as heavy rains impacted the country in August.

There were at least four billion-dollar insurance events associated with severe convective storms. Parts of southern Europe, particularly Italy, were hit by a repeated storm activity during the month of July. This resulted in exceptional insurance payouts in Italy and the costliest weather-related event on record for the country. Total payouts related to multiple hailstorm events in July was expected to reach €3.7 billion ($4.1 billion).

Insurance payouts exceeding $2 billion were also recorded due to Windstorm Ciarán, which primarily affected northwestern France in early November and became the costliest windstorm in the country since Xynthia in 2010.

In early September, a powerful earthquake struck Morocco, becoming the most devastating event in Africa in 2023 and in the last 20 years, when the Boumerdes earthquake in Algeria caused economic losses of more than $8 billion.

While not associated with direct economic and insurance losses, two major heatwaves contributed to thousands of excess deaths. July's Cerberus heatwave resulted in nearly 6,000 fatalities, and was followed by extremely high temperatures in August, which were linked to 8,300 deaths in southern Europe, mainly Spain and France.

APAC (Asia and Pacific)

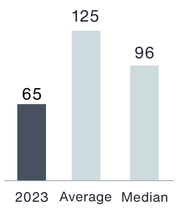
China Floods
Series of costly events, including Beijing Floods
$32.2B economic loss, $1.4B insured loss, 370 fatalities

Afghanistan Earthquakes
Four M6.3 earthquakes jolted Afghanistan's Herat Province in October $100M+ economic loss, 1,489 fatalities

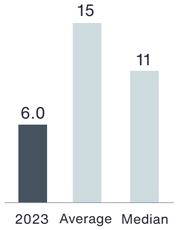
Cyclone Mocha
Severe storm to hit vulnerable region, particularly Myanmar
$2.3B economic loss, 466 fatalities

Auckland Floods and Cyclone Gabrielle
Two costliest weather-related events on record for New Zealand insurers $7.1B economic loss, $2.3B insured loss, 15 fatalities

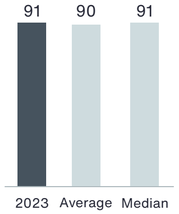
Economic Losses (2023 $ billion)



Insured Losses (2023 $ billion)



Protection Gap (%)

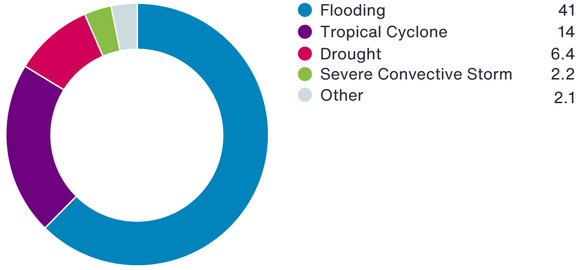


17%
of global economic losses

5%
of global insured losses

9%
of losses covered by insurance

Economic Losses (2023 $ billion)



2,250+ mm (88.6+ in)
Multiday rainfall total brought by Cyclone Jasper and its remnants in Bairds, Australia

-53 °C (-63.4 °F)
The only national all-time minimum temperature record set in China on January 22

342.7 kph (212.9 mph)
The third strongest wind gust on record worldwide generated by typhoon Koinu on Lanyu Island, Taiwan

8
Number of tropical cyclones that affected Philippines from May to December 2023

Total economic losses in the APAC region in 2023 reached $65 billion with a substantial protection gap of 91 percent. Economic losses were 48 percent lower than the average and 32 percent below the median of the 21st century.

Insured losses in the APAC region reached approximately $6 billion and were notably below the 21st century average of $15 billion. Even though the statistic is skewed by the outlier year of 2011 (Great Tohoku EQ in Japan), 2023 insured losses, which were particularly driven by events in New Zealand, remained 44 percent lower than the median.

About half of the APAC losses were related to flooding in China, which resulted in more than $32 billion economic losses and $1.4 billion of insured losses. Flood losses continued to maintain dominance as the costliest peril for the fourth consecutive year, accounting for more than 64 percent of the loss total this year. Much of the flood losses in 2023 occurred in South and Southeastern Asia, where the insurance penetration remains very low.

In APAC, flooding remained a recurring threat with annual losses exceeding $30 billion every year since 2010. Many places saw significant flooding and record rainfall events in 2023 — New Zealand, Japan, Hong Kong, South Korea, India, and Pakistan. The South Asia floods (Pakistan and India) left nearly 2,900 fatalities.

Nearly a half of the APAC insured losses were related to two notable events that hit New Zealand from late January to February. Widespread flooding in Auckland resulted in $3.4 billion of economic and $1.3 billion of insured losses. Only three weeks after, Cyclone Gabrielle caused additional losses in the billions of USD. These two events thus became the costliest weather-related events for the local insurance sector on record on an inflation-adjusted basis.

Australian insurers suffered notable losses after the Newcastle hailstorm in May, and particularly in December, when two significant events occurred. One was widespread flooding in north Queensland after the impact of Cyclone Jasper, and the other were the Christmas storms that impacted eastern Australia and resulted in more than 65,000 claims.

With economic losses of nearly $13 billion and insured losses of $1.4 billion, tropical cyclone losses for Asia and Oceania were 53 percent and 70 percent below their 21st century averages. Number of fatalities from tropical cyclones stood relatively low in the second year in a row. This might be a result of improved disaster response and adaptation measures, however, many communities remain vulnerable in countries such as Myanmar, where at least 463 people died due to impact of Cyclone Mocha in May.

The APAC region was rocked by several large earthquakes in 2023. Nearly 1,500 people were killed after earthquake series in Afghanistan’s Herat Province in October, more than 200,000 homes were damaged in China’s Gansu Province in December.

Almost the entire region experienced prolonged periods of extreme temperatures in 2023. Notably, a multi-week-long heatwave impacted many countries in South and Southeastern Asia in April and May. Additional losses in billions of USD resulted from drought conditions that affected particularly China and India.

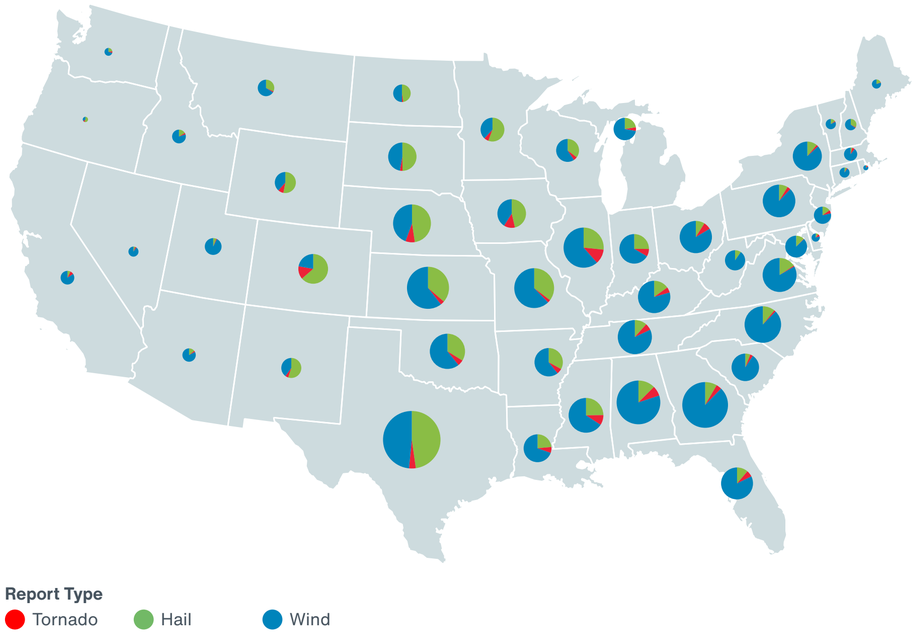
2023 Natural Peril Review

Insight into the impact of significant 2023 disasters on society and the global (re)insurance industry.

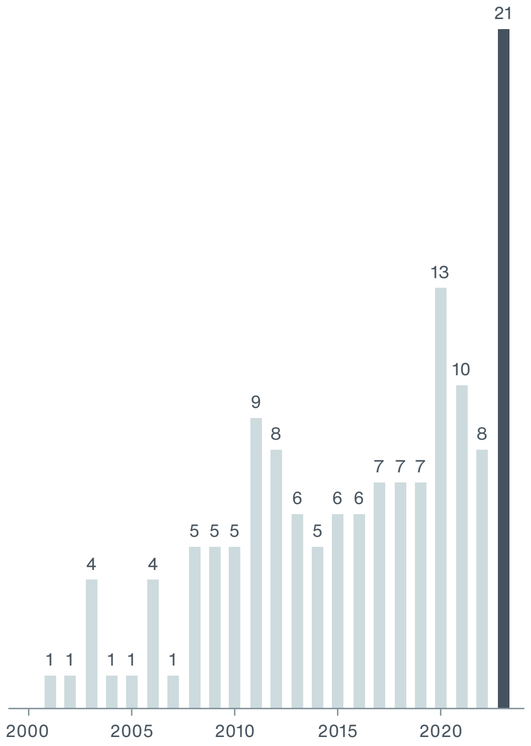
Severe Convective Storms Break Historical Records in 2023

Exhibit 21: U.S. Storm Reports in 2023 and Number of Costly Insured Loss Events

Number of 2023 SPC Reports by State



Number of SCS Events Above $1B



Data: Aon Catastrophe Insight, Storm Prediction Center

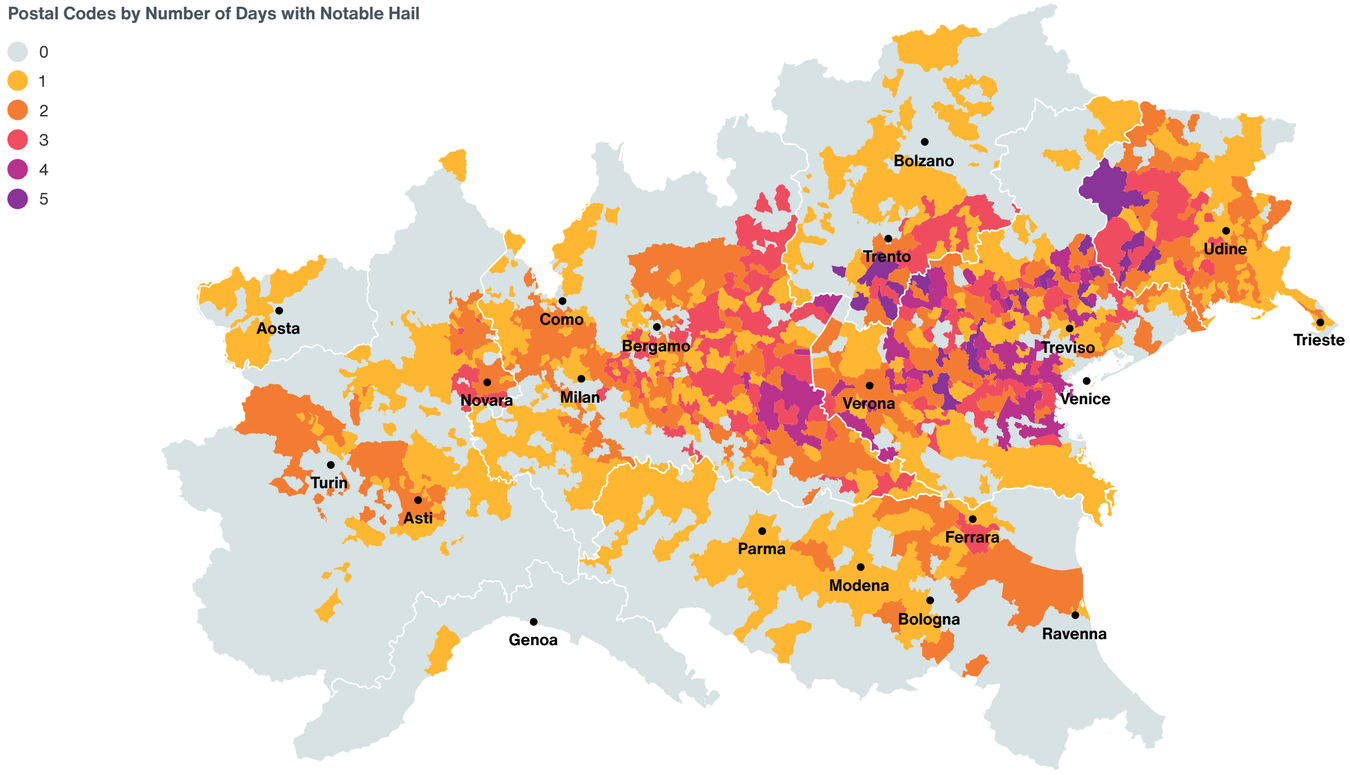
Even when considering the trend of increasing disaster losses in the 21st century, SCS peril stands out significantly in 2023. In the United States alone, insured losses from the peril exceeded $50 billion for the first time on record and the preliminary total stands at $58 billion, compared to the previous record of $44 billion set in 2020.

Despite the practice of including SCS in the so-called secondary perils, it has undoubtedly become a major loss driver, generating ever increasing number of costly medium-sized events. In the U.S. alone, this includes 10 multi-billion-dollar insured loss events in 2023.

Hail damage in the United States was exceptional in 2023, especially in Texas and Colorado. While hail caused the majority of total SCS losses, wind impacts were still significant. In fact, the Storm Prediction Center recorded the second highest preliminary wind report annual total (17,579) since 2005. Moreover, the year 2023 featured multiple noteworthy tornado outbreaks, including the third largest tornado outbreak in United States history between March 31 and April 1.

As SCS-related economic and insured losses continue to increase, understanding the drivers behind this is crucial for insurers. While current scientific knowledge does not explicitly show climate change's impacts on the frequency and severity of SCS, there is evidence that exposure growth is responsible for most of the increase in associated losses[2].

Exhibit 22: Northern Italy July 18-26 Hailstorm Footprints Modelled by Aon Impact Forecasting



Data: Aon Impact Forecasting, ESSL

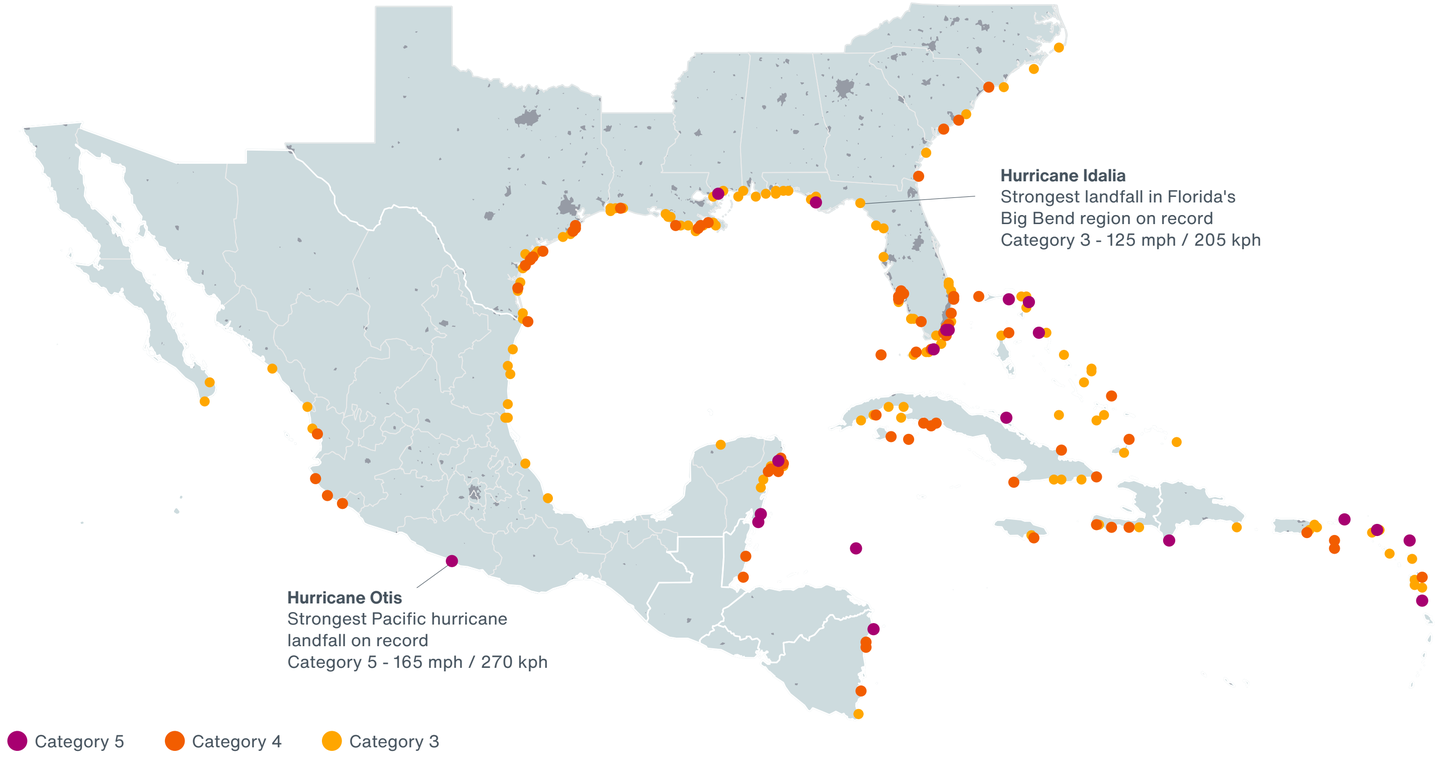
Major severe storms were not limited to the United States. As reported by the European Severe Storm Laboratory, the largest verifiable hailstone in Europe on record fell on July 24 near Azzano Decimo in northern Italy and measured 19 cm (7.5 inches) in diameter. This was close to the world record of 20.3 cm (8 inches), recorded in Vivian, South Dakota in the United States[3].

It was recorded during a period of relentless storm activity across Northern Italy between July 18 and 26. The total damage, which resulted from the entire sequence of events in July, was unprecedented for the country. Local insurers faced aggregated payouts reaching approximately €3.7 billion ($4.0 billion), marking the costliest weather-related annual losses in Italian history. It is noteworthy that the country also faced several episodes of widespread flooding in 2023, which similarly generated significant payouts for the industry.

The July hailstorm sequence coincides with **the findings of a new study**[4]. This research documents that the observed increase in the number of hail reports in Northern Italy is consistent with a novel modeled approach. Authors noted that the region is a European hail “hotspot” and that very large hail (≥5 cm/2 inches) is now three times more likely to occur here than in the 1950s.

A Tale of Two Hurricanes: Idalia and Otis

Exhibit 23: Major Hurricane (Cat 3+) Landfalls in the Atlantic and Eastern Pacific



Data: HURDAT, NOAA

Idalia and Otis, two of the most destructive hurricanes in 2023, impacted areas unfamiliar with strong tropical cyclones. Despite relatively stable track forecasts for both storms, major differences in intensity forecast performance and affected exposure resulted in drastically different outcomes for the United States and Mexico.

While Hurricane Idalia did outperform initial intensity forecasts from the NHC, rapid intensification was anticipated in the Gulf of Mexico in early guidance. As such, the NHC forecasted Idalia to reach major hurricane status (Category 3+) as much as two days prior to landfall. Moreover, the storm moved onshore in the Big Bend region of Florida, a sparsely populated area of the state. As a result, more severe impacts from Idalia were potentially avoided.

In contrast, the intensity forecast for Hurricane Otis was severely underestimated[5]. Until key reconnaissance measurements were taken merely hours before Otis made landfall, rapid intensification was not explicitly forecasted by the NHC. Unfortunately, this powerful storm directly hit the city of Acapulco, Mexico — a metro area home to nearly 1 million people. The nightmare scenario that unfolded highlights the importance of reliable forecasts, warnings, evacuation plans, and preparation, in the face of more frequent and unexpected occurrences of rapidly intensifying tropical cyclones.

Atlantic

The 2023 Atlantic Hurricane season started exactly on the official start date with the first storm Arlene named on June 1. It was the second year in a row with no named storm before official start of the season, following the eight-year period between 2014 and 2021 when pre-season storms occurred each year.

The Accumulated Cyclone Energy (ACE[6]), a metric that accounts for storm and/or seasonal intensity and longevity, ended up at 145.6 for the Atlantic basin; 19 percent above the 1991-2020 average, despite the presence of El Niño conditions, which typically results in lowered tropical cyclone activity. El Niño usually weakens the Bermuda High, allowing storm systems to curve northward or take more easterly tracks out to sea, as opposed to being pushed westward towards the continental United States, Mexico, or Central America. Consequently, only a few systems impacted land or caused significant damage this season.

In total, above-average number of 20 named storms occurred, and 7 Atlantic hurricanes formed in 2023. Three of them attained major hurricane status (Category 3+): Franklin, Idalia, and Lee.

Hurricane Idalia was one of the most pronounced storms as it was the only U.S. landfalling hurricane in 2023. Idalia made landfall in Florida in late August as a Category 3 storm, causing the economic losses around $3.5 billion and became the costliest tropical cyclone within Atlantic basin.

Tropical storm Ophelia, with landfall in North Carolina, and post-tropical cyclone Lee, with landfall in Nova Scotia, were the only other systems to make landfall in North America in 2023.

Eastern Pacific

The 2023 Eastern Pacific Hurricane season was more active compared to climatology, with near-normal numbers of named storms (17) and hurricanes (10). However, the number of major hurricanes (8) was above the long-term average. Strong hurricanes drove a high aggregate ACE of 164.0, up over 30 units from 1991-2020 average, despite a relatively late start to the hurricane season.

While most storms did not affect land, those that did were quite remarkable. Notably, Hurricane Otis, which became the first Pacific hurricane to make landfall at Category 5 intensity, devastated the city of Acapulco in Mexico. The country was already badly hit by tropical storms this year with six direct storm landfalls: Hilary, Max, Lidia, two landfalls of Norma and Otis. Between these storms, only Hurricane Hilary brought further impacts to the United States with historic rainfall across several western states.

Long-lived Category 4 storm Dora was another notable storm of the season and contributed to the catastrophic, deadly wildfires in Hawaii even without directly impacting the islands.

Western Pacific

The Western Pacific basin recorded another successive year of below-normal tropical cyclone activity, with 16 named storms, 11 typhoons, and 8 Category 3+ typhoons. This was lower than the basin's climatology from 1991-2020 with 25 named storms and 16 typhoons, and near-average with 9 Category 3+ typhoons. Despite fewer storms, the ACE value reached 271.7, slightly below the basin's long-term average of 299.5.

Notably, Guam was hit hard by super typhoon Mawar, which was tied with super typhoon Bolaven as the strongest storm of the season by maximum wind gusts.

The Philippines faced the effect of at least eight tropical cyclones between May and December 2023. Super typhoon Doksuri was one of the most severe, leaving hundreds of casualties and resulting in extensive damage across the Philippines, China, and other countries. Additional losses were caused by super typhoons Khanun and Saola. The remnants of typhoon Haikui brought record-breaking rainfall to Hong Kong.

Exhibit 24: 2023 Global Tropical Cyclone Activity by Basin Compared to Climatology*

Basin	Named Storms		Hurricanes (Category 1+)		Major Hurricanes (Category 3+)	
	2023	Climo	2023	Climo	2023	Climo
Atlantic	20	14	7	7	3	3
Eastern Pacific	17	17	10	9	8	5
Western Pacific	16	25	11	16	8	9
North Indian	8	5	4	2	3	1
Northern Hemisphere	**61**	**61**	**32**	**34**	**22**	**18**
Southern Pacific	8	10	7	5	5	2
South Indian	5	16	5	9	2	4
Southern Hemisphere	**13**	**26**	**12**	**14**	**7**	**6**
Totals	**74**	**87**	**44**	**48**	**29**	**24**

*Compared to the 1991-2020 climatological average. TCs within all basins are classified based on the Saffir-Simpson hurricane wind scale. Southern Hemisphere statistics include full calendar year 2023 events.

Source: National Hurricane Center; Joint Typhoon Warning Center; Colorado State University

North Indian Ocean

The North Indian Ocean saw above-average cyclone season, with 8 named storms, 4 cyclones and 3 Category 3+ cyclones. This included deadly cyclone Mocha, which made landfall in Myanmar, cyclone Biparjoy with landfall in India, and cyclone Tej that affected Yemen and Oman. With accumulated cyclone energy of 57.5, this year's storms produced the second-highest ACE value on record, only behind 2019 with 93. The long-term average stands at 24.3.

Southern Hemisphere

In 2023, the number of named storms stood relatively low compared to the long-term average. However, several strong Category 3+ storms occurred, particularly within Southern Pacific basin. In Oceania, a pair of intense tropical cyclones Judy and Kevin wreaked damages in Vanuatu. Cyclone Jasper and its remnants brought record-breaking rainfall over Australia's Queensland in December. This year's season was also one of the deadliest on record, mostly due to cyclone Freddy which killed more than 1,400 people across southeast Africa. Cyclone Cheneso was another deadly and long-lived storm to affect Madagascar.

Atlantic Ocean

- 2023 Atlantic hurricane season ranks fourth for the most-named storms in a year, and the most named storms of any El Niño influenced year was produced
- **TS Bret** and **TS Cindy** marked the first time two storms were active at one time in June since 1968
- On August 20-22, four TS (**Emily**, **Franklin**, **Gert**, and **Harold**) formed within 39 hours, marking the fastest naming of four storms since 1893
- Sustained wind gusts generated by **HU Lee** increased by 85 mph/135 kph in the 24-hour period, the third-fastest intensifying Atlantic hurricane on record, behind HU Felix (2007) and HU Wilma (2005)
- With a maximum sustained winds of 125 mph/205 kph during landfall, **HU Idalia** became the first major hurricane to enter Apalachee Bay (an area offshore from Florida's Big Bend region) in recorded U.S. history. HU Idalia was also the first hurricane to hit the region since Category 2 HU Gladys in 1968

Pacific Ocean

- **HU Otis** became the first Pacific hurricane to make landfall at Category 5 intensity. Hurricane's maximum sustained winds increased by 115 mph/185 kph in a 24-hour period, ranking as the second-fastest worldwide behind HU Patricia in 2015
- **HU Dora** passed south of the Hawaiian Islands and contributed to strong gradient winds over Hawaii, enhancing conditions for devastating wildfires in early August. Dora also became only the second TC on record to be at hurricane strength in the Eastern, Central and Western Pacific basins, after HU John in 1994. Dora maintained Category 4 intensity longer than any Pacific hurricane on record
- **HU Adrian**, developed on June 27, became the second-latest forming first named storm in the Eastern Pacific in the satellite era (since 1971)
- **TY Mawar**, equivalent to Category 4 hurricane, became the strongest storm to affect Guam since TY Pongsona in 2002
- The remnants of **TY Haikui** brought 158 mm/6.2 inches of rain in one-hour period, the highest hourly rainfall since 1884 in Hong Kong. Daily rainfall totals surpassed 900 mm/35.4 inches
- **TY Koinu** generated wind gust of 342.7 kph/212.9 mph on Lanya Island, Taiwan, marking unofficially the third world's strongest wind gust on record

Indian Ocean

- **CY Freddy** set the highest ACE for a single tropical cyclone on record worldwide with 87.01
- **CY Freddy** now holds the record as the longest-lasting tropical cyclone worldwide
- **CY Freddy** was the first tropical cyclone to undergo seven separate rounds of rapid intensification.
- CY Litanne (1994), CY Leon–Eline (2000), CY Hudah (2000), and **CY Freddy** are the only storm systems to traverse the entirety of the southern Indian Ocean from east to west

How New Buildings Use Emerging Innovation for Climate Resilience

To confront the effects of climate change, firms are exploring new approaches to buildings, materials and project planning. However, these transformations are often accompanied by logistical challenges, uncertainty and risk navigating varying construction goals and timelines.

In the face of major weather perils like heatwaves and torrential rain, as well as a focus on more stringent environmental building requirements, both project owners and construction companies are more focused on building weather and climate resilient structures. Developers, suppliers and contractors each have unique cost considerations, which can influence decisions about green construction materials and building strategies. What's more, the production of some raw materials used in developing renewable energy infrastructure has been curtailed or stopped entirely due to rising costs, slowing the progress of renewable infrastructure development.

Making changes to construction materials and methods could create lasting and positive outcomes for the environment, though in some cases, builders may face higher up-front costs or logistical problems. Sourcing the right supplies takes time, and the definition of what truly makes a building material or process "green" is still up for debate.

Emerging Innovation in Building Standards

- Location-specific guidelines are influencing climate-friendly building decisions. For example, the government of British Columbia has proposed an update to its building codes in response to increasing heatwaves. The code would require all new homes to have at least one temperature-controlled room not to exceed 26 Celsius, through passive cooling measures such as shading or air conditioning.
- Low-carbon 3D printing models give builders a way to cut down on construction time and smart building sensors that reduce energy output. Renewable energy also plays a key role. The International Energy Agency estimates renewables will account for almost 95 percent of the increase in global power capacity through 2026. Innovative technologies, such building integrated photovoltaics (BIPV) that combines energy efficient solutions with modern design, contribute meaningfully to more sustainable building standards.
- White paint can reduce building temperatures by reflecting light and heat, and a new kind of paint could reflect up to 98 percent of the sun's rays. Bricks made from algae are also on the horizon, giving builders a way to lower their carbon footprints from the ground up.

Given this innovation, builders must now consider the financial consequences of creating structures that fail to meet current standards for both chronic perils and energy efficiency. However, the added complexity of extreme weather events is driving up insurance premiums, making building projects more costly. Meeting these needs requires an agile approach to insurance coverage.

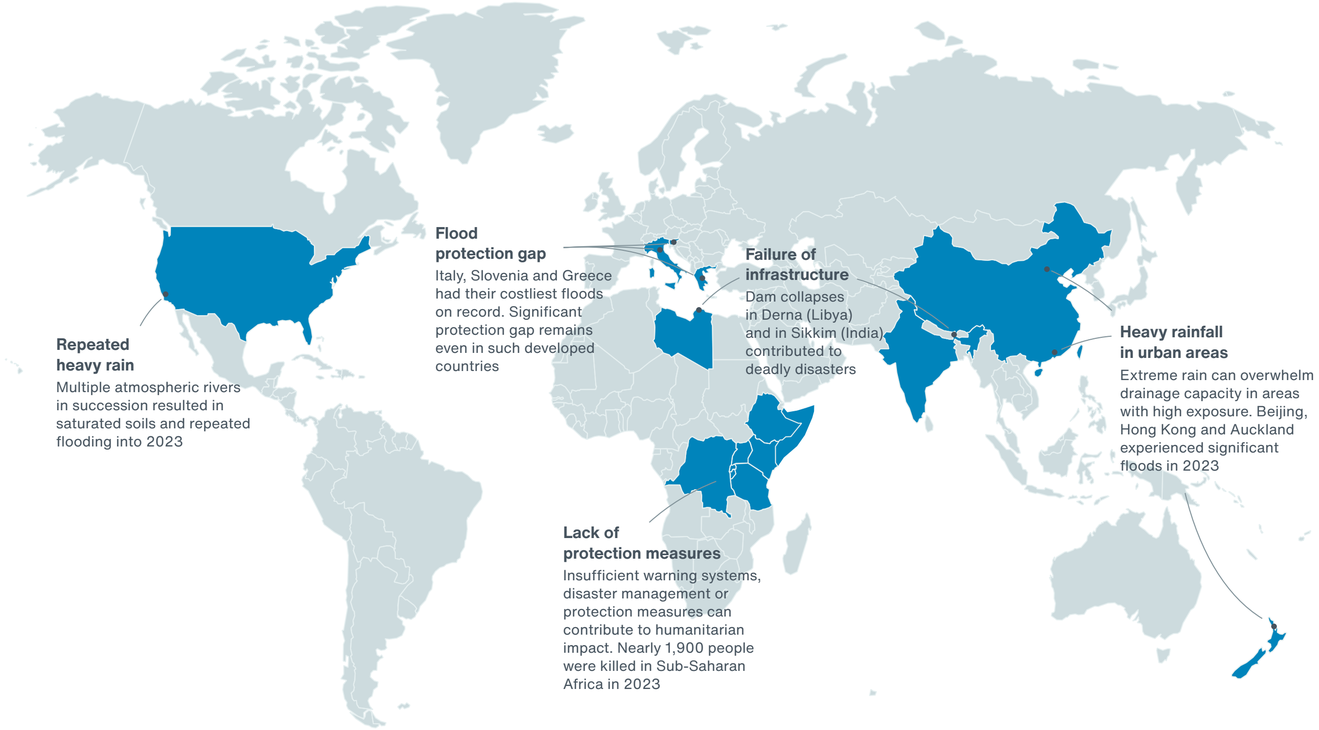
Furthermore, taking practical measures coupled with analytics to show an accurate exposure to risk, means that insurance can be an enabler on a larger scale to fuel innovation and create new markets across construction and renewables alike. All parties need to understand what risk they are taking and whether, as a contractor for instance, they can insure, mitigate or transfer the risk to create resilience.

To read more, visit our article: How the Construction Industry is Navigating Climate Change.

Chris McLean
Managing Director, National Leader
Construction and Infrastructure, Aon

Flooding Events Test Resilience of Communities Across the Globe

Exhibit 25: Significant Flooding Events in 2023

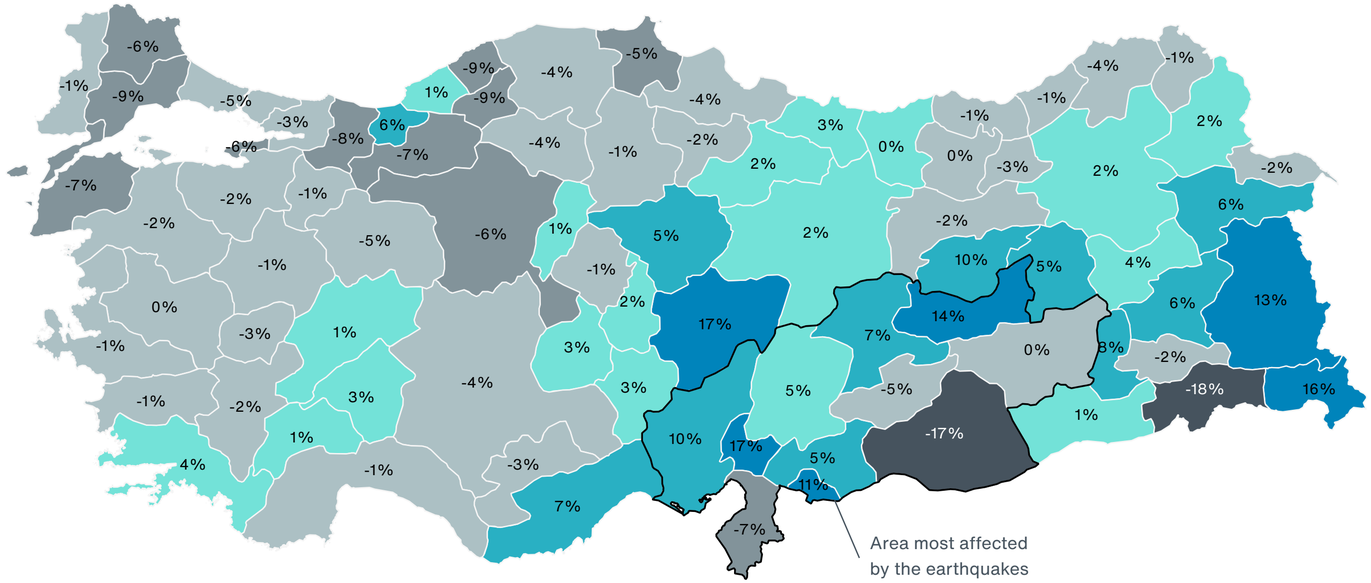


Costly flooding events across the globe provided an opportunity to see and compare what role insurance can play in the overall resilience of communities. While flood insurance take-up generally tends to be lower even in developed regions such as Europe, other countries exhibit a very limited or even non-existent coverage, and the costs have to be covered by population and governments. Increase in flood coverage is quickly emerging in territories such as China, where flooding generated payouts in excess of $1 billion in 2021, 2022 and 2023. The large-scale disasters of 2023, including the flooding in Greece, prompted respective national governments to initiate discussion about the role of insurance in stabilizing the economy after such occurrences and about potential changes to how these events are covered; in various countries, this might include a mixture of public and private insurance and compulsory schemes.

Investing in infrastructure and its proper maintenance appears to play a major role in how vulnerable countries are to heavy rainfall events. The deadly flash flood in Derna, Libya, was an example of a compound event, which was exacerbated by a failure of dams above the city. Similarly, a glacial lake outburst flood in India on October 4 renewed controversies around infrastructure projects in areas prone to such disasters. Maintenance of drainage infrastructure plays a major role in major urban centers, as highlighted in the historic floods in Beijing in late July.

Earthquake Consequences in Context of Inflation and Migration

Exhibit 26: Change of the TCIP Insurance Take-up Between 2021 and 2023



Data: TCIP

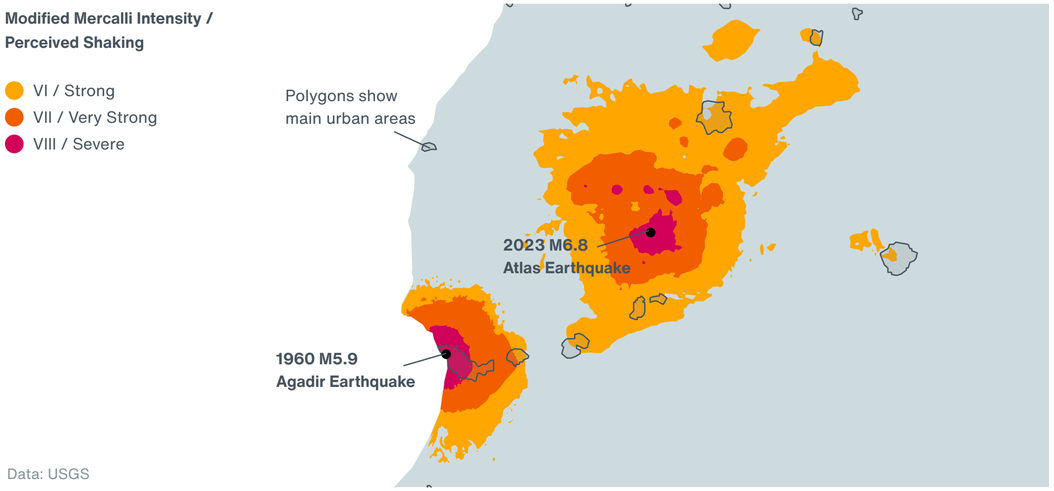
The earthquake sequence in Turkey and Syria, which was the costliest and deadliest event in the entire EMEA region on record, damaged more than 340,000 buildings and resulted in nearly 60,000 deaths.

The compulsory public insurance scheme facilitated by the TCIP suffered a loss of nearly TRY36 billion ($1.2 billion using the currency exchange rate as of January 2024), which prompted notable changes within the scheme. Focusing on longer term, it appears that many regions of Turkey experience stagnation or even decrease of the penetration, most notably in the wider Istanbul region. One of the reasons behind this shift can be linked to inflation, which makes residential property more expensive, and this might result in the current TCIP coverage being viewed as insufficient and too costly. Another factor adding to a long-term decline can be low insurance awareness.

The February event appears to have contributed to some increases in insurance take-up rates in the affected provinces, notably Elazığ (+14 percent), Osmaniye ili (+17 percent) and Kayseri ili (+17 percent). At the same time, substantial decreases in the proportion of covered property can be seen in extreme southeast, in provinces likely directly affected by the military conflict and unrest in Syria and subsequent migration from these provinces.

Responding to Disasters: Morocco Earthquake

Exhibit 27: Morocco Earthquake Footprint



On September 8, a devastating earthquake impacted the High Atlas Mountains in Morocco and killed 2,946 people. Resulting material damage also generated notable loss for the local insurance industry. In response to such catastrophes, Aon Impact Forecasting team is able to prepare hazard footprints for the purposes of catastrophe modelling, which can help re/insurers to quickly estimate potential losses after an event.

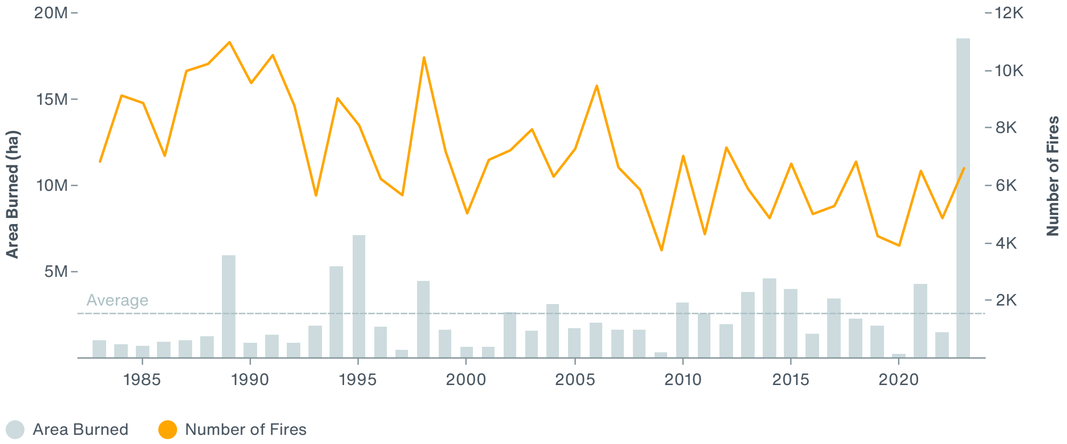
Exhibit 28: Examining the Earthquake Damage in Talat N'Yaaqoub

Source: Aon Impact Forecasting

Beyond catastrophe modelling, in situ observation can provide valuable insights into structural damage on buildings and infrastructure. These can include data on how various types of buildings performed, including total collapses or typical X-shaped cracks on unreinforced masonry. This in turn can help provide insight needed to improve the catastrophe models used in re/insurance.

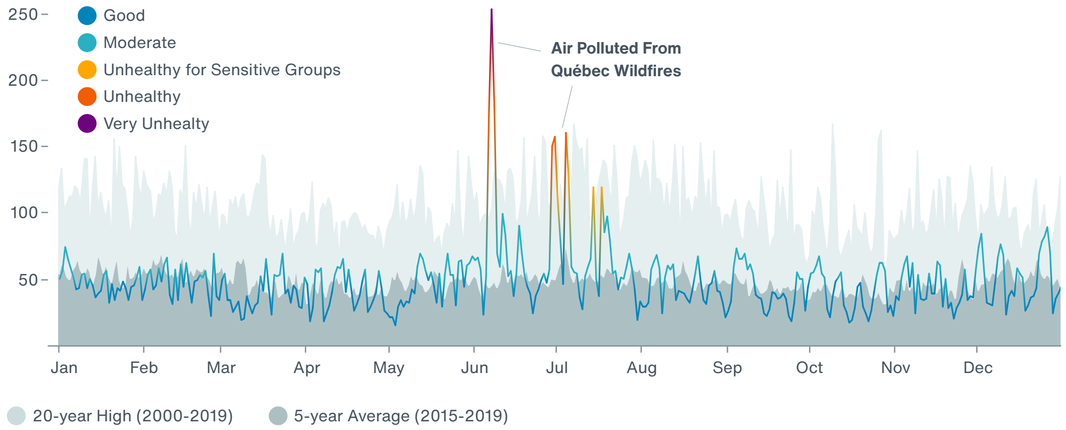
Secondary Impacts From Wildfires Beyond Property Damage

Exhibit 29: Area Burned by Wildfires in Canada (hectares)



Data: CIFFC, CWFIS

Exhibit 30: PM2.5 Air Quality Index in New York in 2023

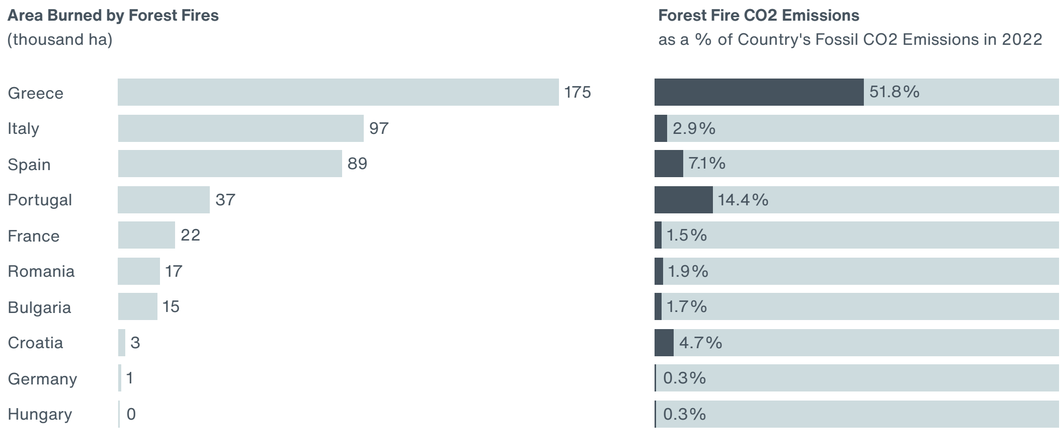


Data: U.S. EPA

Canada experienced an unprecedented wildfire season in 2023. Approximately 18.5 million hectares (45.7 million acres) of land was burned, smashing the previous annual high from 1995 nearly three times over. Favorable conditions were likely driven by altered rainfall patterns and elevated temperatures. Although wildfire extent was enormous, material losses did not exceed record highs. However, this year's wildfires caused notable structural and vehicular damage and resulted in economic losses of $1.5 billion and insured losses of at least $760 million. The costliest wildfires, West Kelowna and Bush Creek fires, occurred in British Columbia. Other severe wildfires appeared across Northwest Territories, Québec, Nova Scotia, and Alberta territories.

Moreover, Canadian wildfires generated considerable secondary impacts throughout the year. In June, thick smoke plumes from the fires extended to south, and affected parts of north-eastern United States with unhealthy air quality conditions for tens of millions of people. Several cities, including New York, saw their worst air quality on record. Smoke from fires dropped solar farms production and delayed hundreds of flights in the region. Canadian wildfires produced 23 percent of the global wildfire carbon emissions for 2023: 480 megatonnes of carbon (MtC) from the global total of 2,100 MtC[7]. This amount was three times higher compared to the Canadian fossil carbon emissions of 150 MtC in 2022.

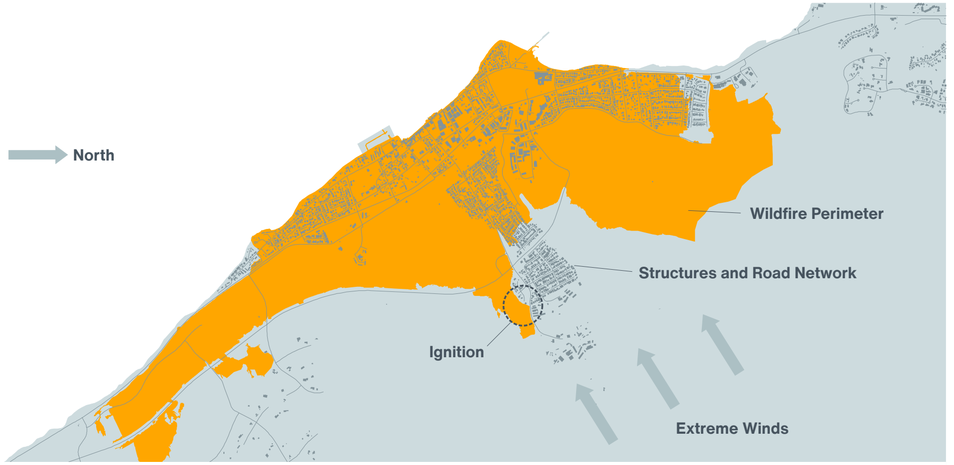
Exhibit 31: 2023 Forest Fires in Europe



Data: EFFIS, Global Carbon Budget

Greece recorded the largest area burned by forest fires in the European Union in 2023, accounting for nearly one-third of EU extent with about 175,000 hectares (432,000 acres) of burned land. July fires became another economic billion-dollar event for Greece. The European Forest Fire Information System (EFFIS) also includes information on estimated amount of CO_2 emissions released from the fires. Comparison with the respective country's fossil emission is displayed on the right. Wildfires in Greece produced about 8.4 MtC in 2023[8], astonishing nearly 52 percent of country's fossil carbon emissions of 16.3 MtC produced in 2022.

Exhibit 32: Lahaina Wildfire Perimeter

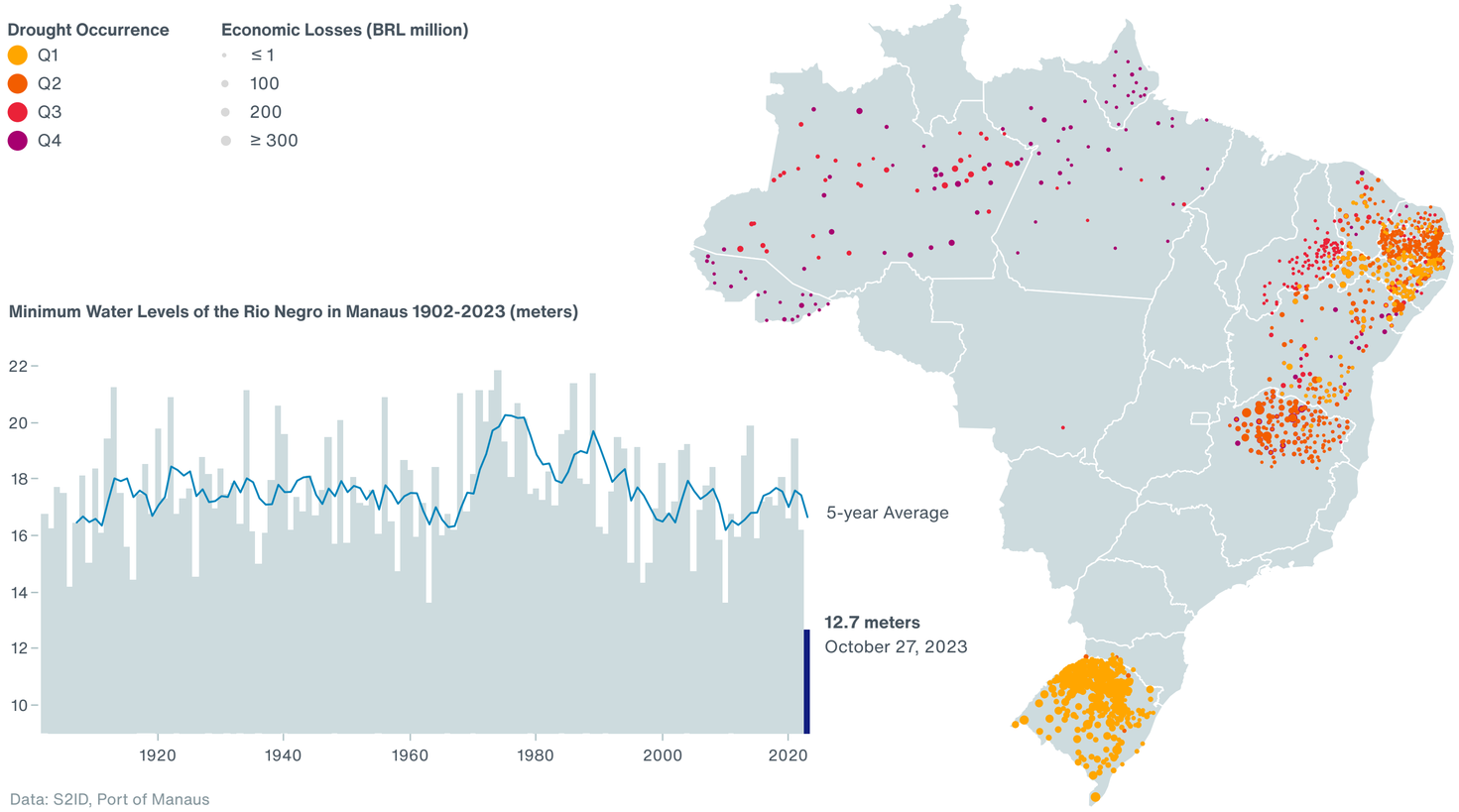


Data: NIFC, FEMA

Compared to recent years, the United States experienced a quieter wildfire season than normal in 2023. At 2.6 million acres (1.1 million hectares) burned, this year fell well below the annual average (7 million acres/2.8 million hectares) over the previous decade. Despite this, more people were killed by wildfires in 2023 than in any year over the last century of United States history. This was mostly due to the devastating Lahaina fire in August, which was responsible for 100 deaths — exceeding the death toll from the recent California Camp Fire (85) in 2018.

Droughts Continued to Impact North and South America

Exhibit 33: Drought Losses in Brazilian Municipalities and Historic Water Level Minimums of the Rio Negro



Data: S2ID, Port of Manaus

South America

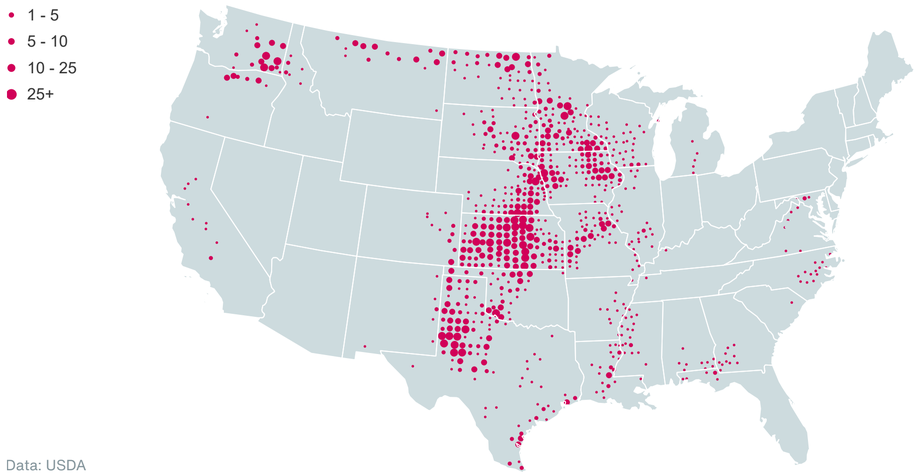
Various parts of South America faced severe drought episodes throughout the year of 2023 that resulted in aggregate economic losses of nearly $18 billion. Prolonged extreme heat and precipitation deficit resulted in extensive agricultural losses across La Plata region since December 2022 and overlapped into Q1, as seasonal drought usually occurs from December to March. Producers in Argentina reported billion-dollar losses and decrease of grain output, particularly soy, corn, and wheat, in the tens of millions of tons.

Additional drought losses took place across Brazil, affecting different parts of the country regarding local drought seasonality. Eastern Brazil experienced multiple drought periods associated with production losses throughout the entire year. Prolonged dry period deepened precipitation deficit across Amazon basin during Q3 and Q4. As a result, Rio Negro, Amazon tributary, recorded its lowest minimum water level on record since 1902.

In terms of extent and duration, multi-annual (2019-2023) drought event is likely to be to be one of the most significant across South America in recent decades[9]. However, drought protection gap remains relatively high in the region.

Note that cross-year drought loss estimates were adjusted to cover calendar year 2023.

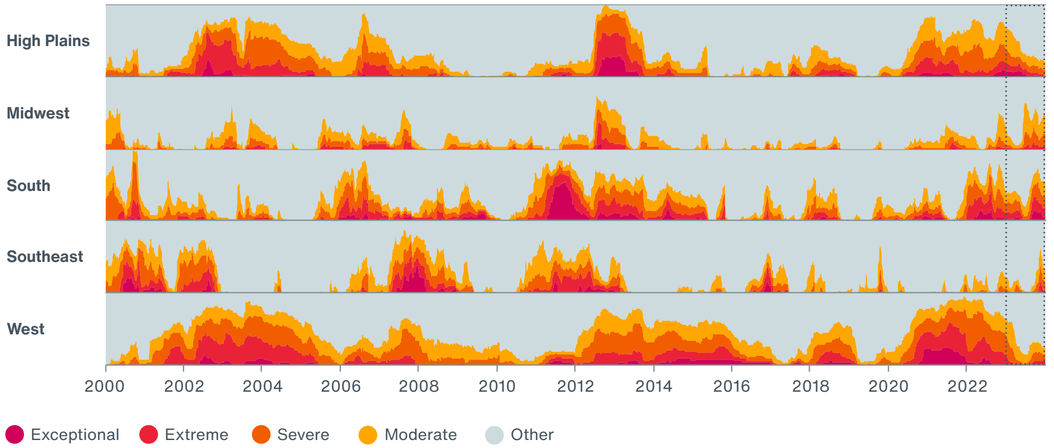
Exhibit 34: U.S. Crop Insurance Payouts from Drought, Heat, Excess Sun and Hot Wind per County ($M)



Data: USDA

In 2022, widespread drought across the United States resulted in crop insurance payouts of more than $10 billion, second only to the record year of 2012. In 2023, drought was not as severe in some regions, yet total payouts again reached approximately $6.5 billion. The highest losses were recorded in Kansas, Texas, Minnesota, Iowa and Nebraska.

Exhibit 35: U.S. Drought Conditions by Region in 2023

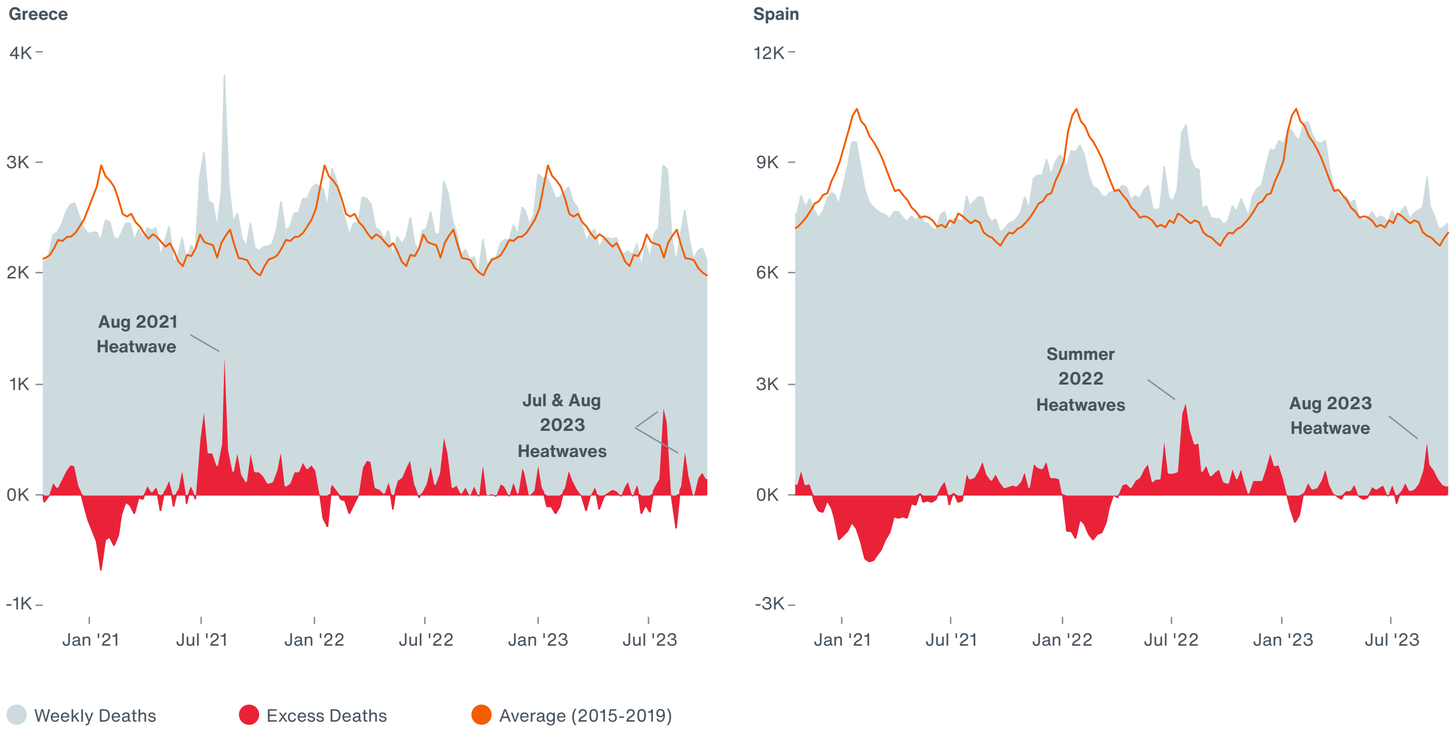


Data: University of Nebraska-Lincoln

Due to extreme heat and a lack of precipitation, drought conditions developed in several regions of the United States during the summer season. While the Plains and Midwest were the worst affected during the beginning of summer, September marked the worst impacts in the Southern United States (Texas, Louisiana, Mississippi).

Extreme Heatwaves Pose Threat to Human Health

Exhibit 36: Examples of Weekly Mortality Data Assessment for Greece and Spain



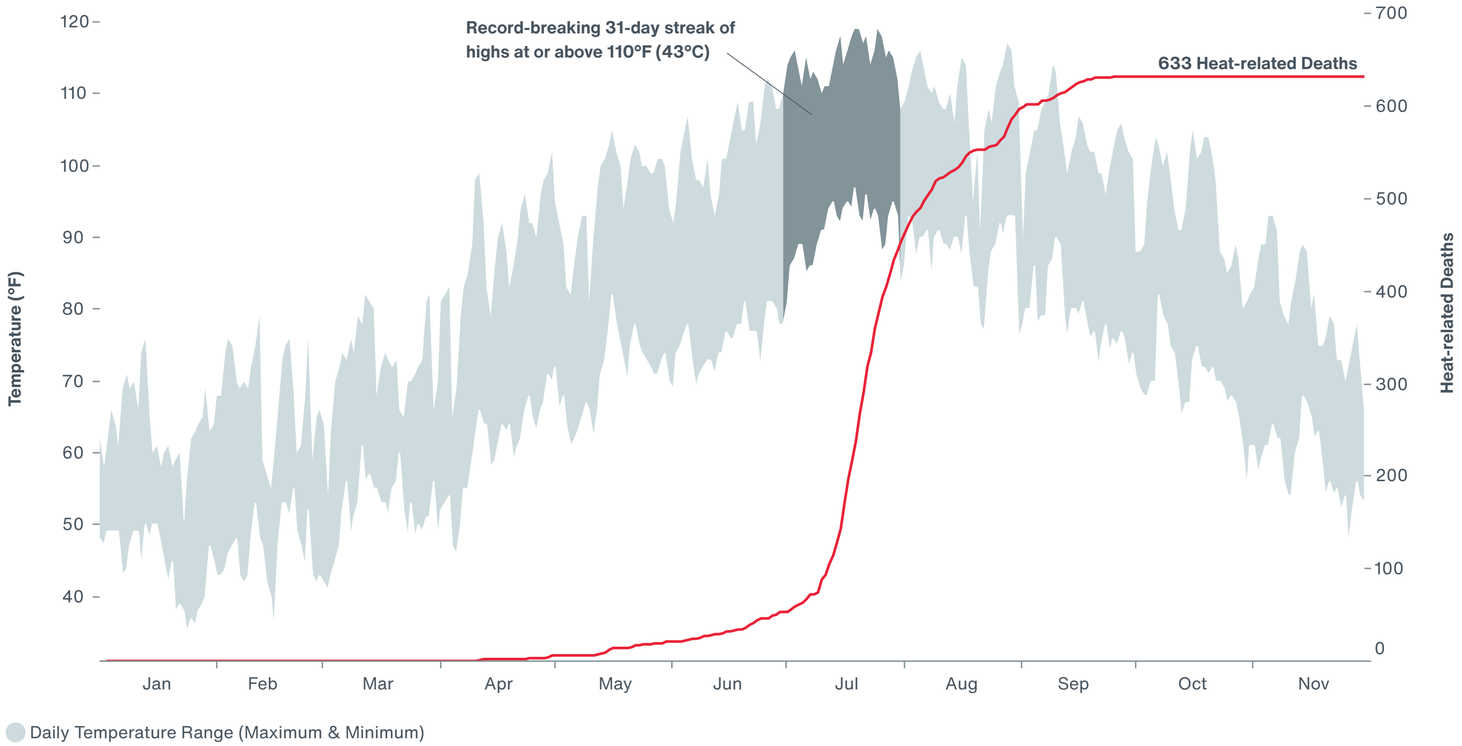
Data: WHO & HMD. Human Mortality Database. Max Planck Institute for Demographic Research (Germany), University of California, Berkeley (USA), and French Institute for Demographic Studies (France). Available at www.mortality.org (data downloaded on Nov 23, 2023).

In the wake of global temperature extremes in 2023, the rising frequency and intensity of extreme heat creates an urgency to consider associated risks to human health and wellbeing. Even though heatwaves are among the deadliest perils, these risks have traditionally been a blind spot in the insurance industry[10].

In 2023, heatwaves claimed at least 16,200 lives worldwide. This total heat-related death toll is an incomplete estimate as tracking heat impact remains problematic in many countries. Catastrophe Insight started accounting for heat-related fatalities in a systematic manner using own methodology and calculations, based on mortality data provided by the Human Mortality Database (HMD[11]) and National Health Institutes. The HMD provides detailed high-quality harmonized mortality and population data, particularly for European countries.

Based on these datasets, three separate heatwaves were identified in Europe in 2023 from July to September, which collectively claimed more than 15,000 fatalities. Moreover, such systematic analysis enables a severity comparison with past events on the regional or national level. See Exhibit 36 with examples for Greece and Spain. Please note that covid-related deaths were excluded from the analysis.

Exhibit 37: Extreme Temperatures Affecting Population in Phoenix, Arizona



Data: Public Health Department, Maricopa County

The number of annual heat-related deaths remains incomplete and underestimated in many countries of the world. While in the United States such assessments might be valuable to the general public, there are only a few estimates on the number of deaths due to extreme heat at the national level. The Centers for Disease Control and Prevention (CDC[12]), which is the main national-level data provider in the U.S., uses mortality coding to derive the annual number of heat-related deaths. However, the estimates appear to be relatively low (in the hundreds or lower thousands) compared to other regions similarly affected by heatwaves. Several studies suggest that the annual number of heat-related deaths should be substantially higher[13].

At the county level, Maricopa County, Arizona, is one example of how to adequately assess and visualize heatwave impacts. The Maricopa County Department of Public Health collects detailed mortality data and publishes reports related to heat[14]. According to the provided weekly data, up to 633 people died in 2023 due to heat. Most of the fatalities occurred in July when Phoenix experienced a record-breaking period of extreme temperatures. In fact, more than 20 people a day died during the hottest days in mid-July.

Notable Events Caused by Additional Perils

European Windstorm

In 2023, European windstorms caused economic and insured losses of $5.0 and $3.6 billion, respectively. The most significant event was Ciarán, which primarily affected northwestern France in early November. This storm caused insured losses estimated at $2.1 billion. It became the costliest windstorm to affect France since Xynthia (2010). The first quarter of 2023 did not generate historically significant events for this peril.

Volcanoes

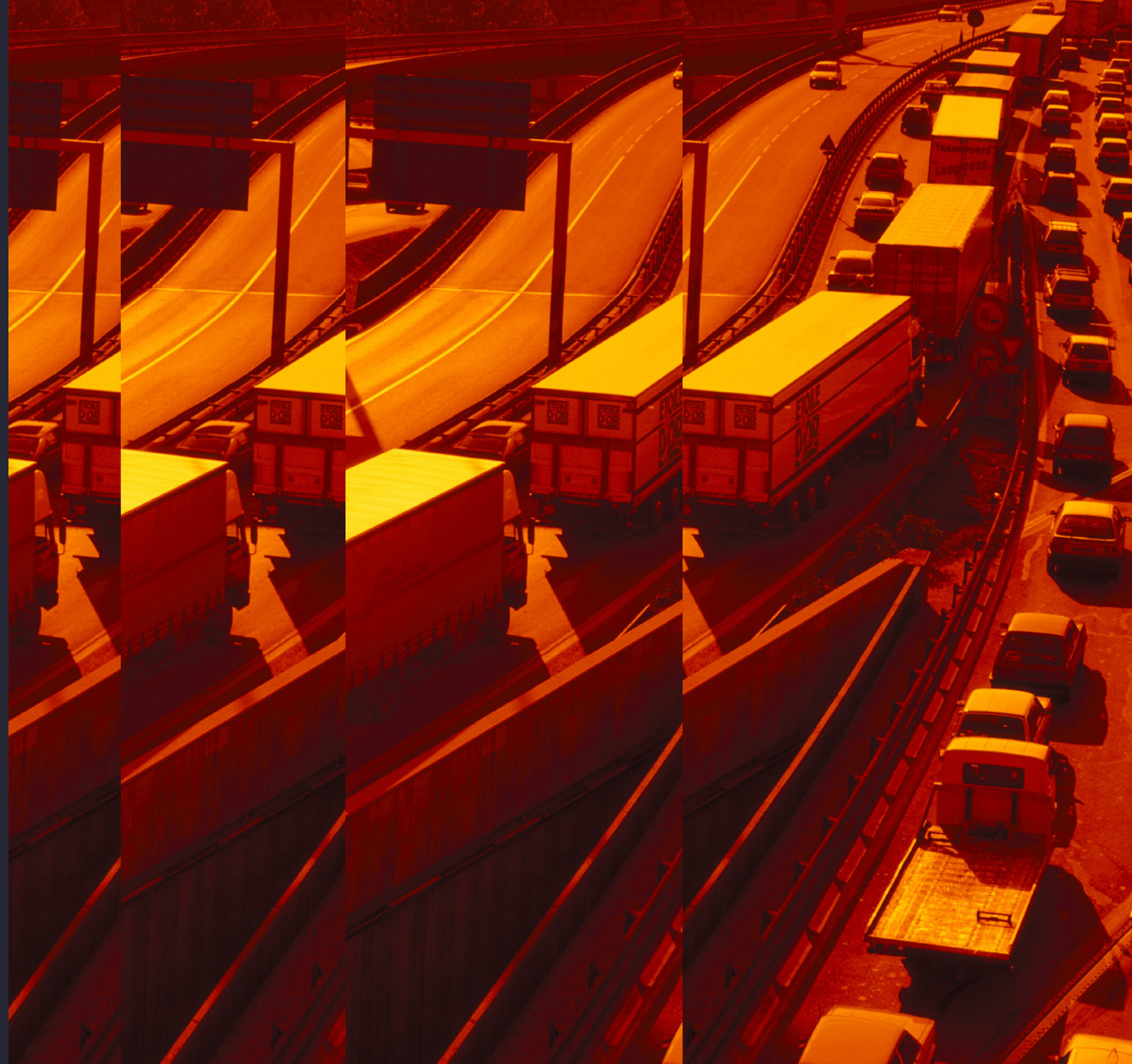
In December, a volcano erupted north of Grindavík, Iceland. The eruption was preceded by tens of thousands of tremors that occurred as early as late October 2023. As a result, approximately $59 million in earthquake-related insurance payouts were incurred, while the erupted material buried largely uninhabited and evacuated areas.

Winter Weather

In January and February, the United States and Canada experienced severe winter weather that affected millions of people. In only three days, the cumulative impact of the North American storms was nearly $1.5 billion in insured losses. China experienced several winter weather events, notably a prolonged period of blizzard conditions and heavy snowfall in December. Record low temperature (-53.0 °C/-63.4 °F) was observed.

2023 Climate Review

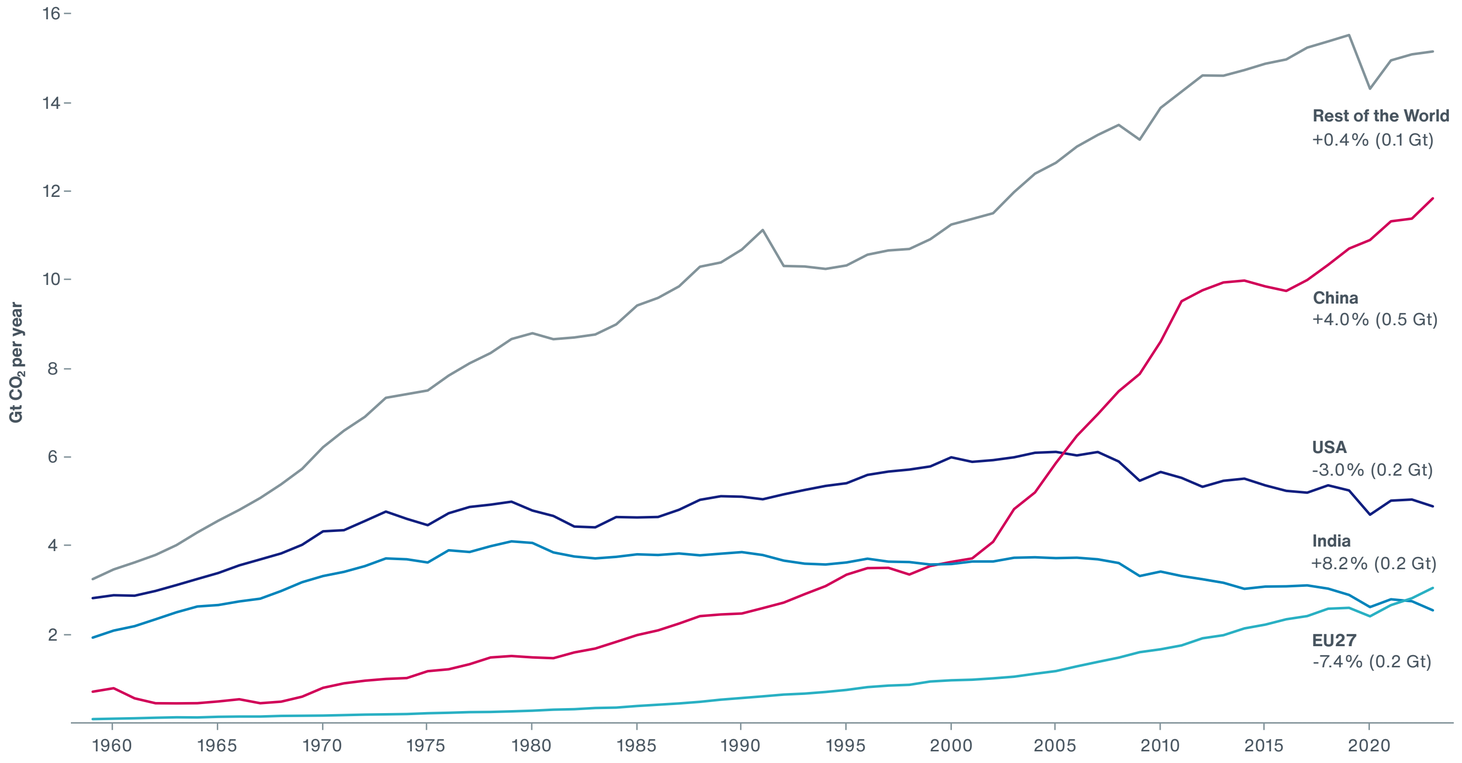
Exploring the global climate and the impact of carbon dioxide emissions, temperature extremes and El Niño.



Global Fossil CO_2 Emissions Increase with Regional Differences

Anthropogenic warming due to increasing greenhouse gas emissions is linked to changes in behavior of certain perils that are relevant for the re/insurance industry.

Exhibit 38: Fossil CO_2 Emissions by Region (Gt/Year) And Expected Change from 2022



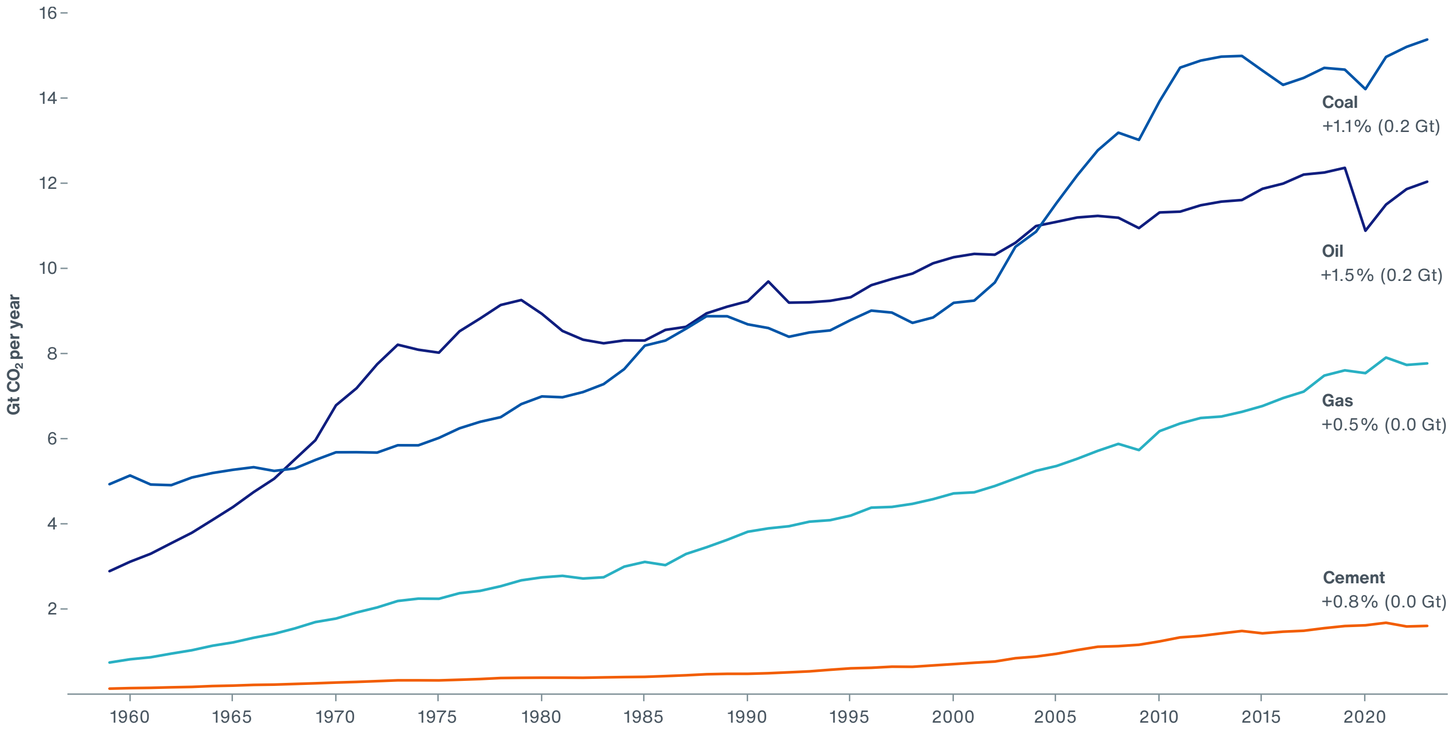
Data: Friedlingstein et al. 2023 Global Carbon Budget 2023. Earth System Science Data 15 5301-5369

According to the latest Global Carbon Budget projections for 2023, CO_2 emissions from fossil fuels will increase by 1.1 percent compared to 2022. However, there are significant regional differences. Large economies such as China and India will likely exceed their total annual emissions in 2022 by 4.0 percent and 8.2 percent respectively, equivalent to 0.5 and 0.2 Gt of CO_2 released per year. In contrast, the European Union and the United States are projected to continue reducing their emissions by 7.4 percent and 3.0 percent respectively, corresponding to 0.2 Gt of CO_2 for both economic regions. With a projected increase of 0.4 percent, the rest of the world will emit 0.1 Gt CO_2 more than in 2022[15].

How are emissions calculated?

In accordance with international guidelines developed by the Intergovernmental Panel on Climate Change (IPCC), countries report their emissions on a bottom-up basis. This means that national emissions are estimated by combining data on the types of activities and emissions they typically produce. For example, if there is information on how much carbon dioxide is produced in steel production and how much steel is produced in a country, it is possible to estimate emissions from the steel sector.

Exhibit 39: Sources of Fossil CO_2 (Gt/Year) and Expected Change From 2022



Data: Friedlingstein et al. 2023 Global Carbon Budget 2023. Earth System Science Data 15 5301-5369

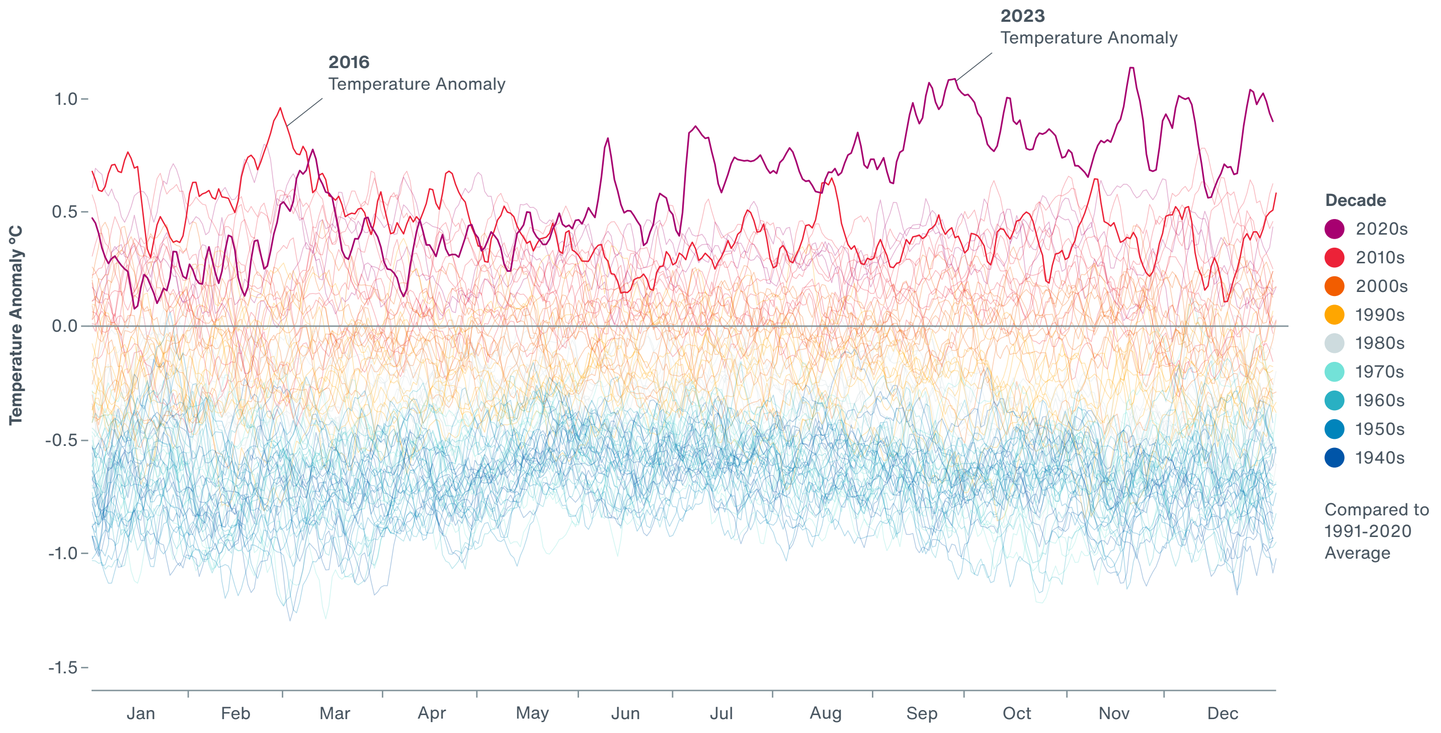
Coal, the largest source of CO_2 emissions, is projected to increase by +1.1 percent (0.2 Gt) in 2023. Emissions from oil processing are also likely to increase by 1.5 percent (0.2 Gt). Emissions from gas extraction and cement production are estimated to increase by less than 1 percent and this change equals to less than 100 million tons of CO_2.

It is important to consider emissions that are released indirectly as a result of human-related warming[16]. These include, in particular, the release of methane from permanently frozen ground (permafrost) which, together with the less reflective surface due to melting glaciers, traps more heat in the climate system and in nature itself[17].

2023 Becomes the Warmest Year on Record

Distribution and duration of temperature extremes changes, exacerbating chronic perils.

Exhibit 40: Global Temperature Anomalies: 1857-2023 (°C)

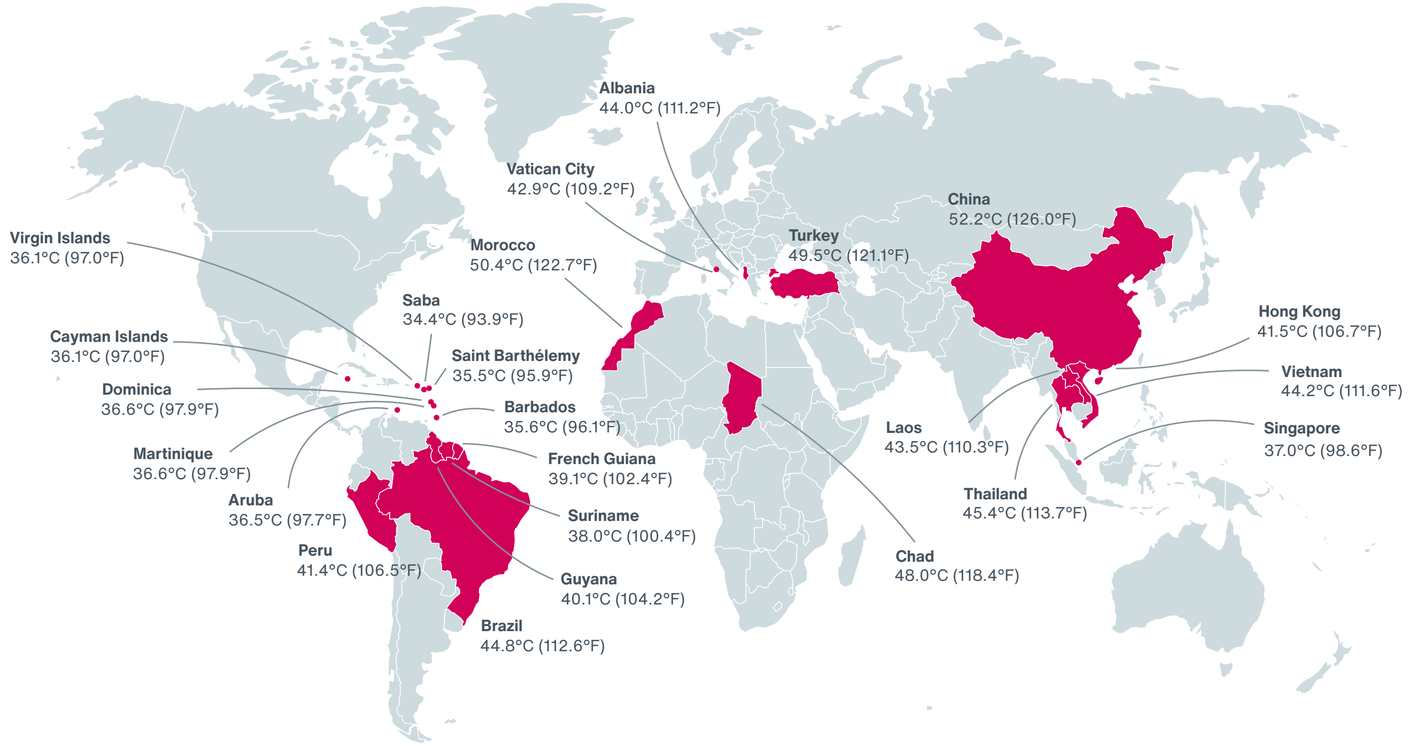


Data: ERA5 Reanalysis, Copernicus Climate Change Service

In line with the rising global mean temperature, 2023 has been recorded as the warmest year since instrumental measurements began[18]. Combining measurements from satellites, ships, aircrafts and weather stations around the world, the World Meteorological Organization evidences that 2023 was 1.45 ± 0.12 °C above the pre-industrial average (1850-1900)[19]. Many European countries broke their monthly temperature records during the Cerberus and Charon heatwaves, marking July as the hottest month on record.

Despite technological advancements, predicting the extent and frequency of heatwaves remains difficult. The latest scientific evidence scrutinizing data going back several decades show that model simulations consistently underestimate heatwave intensity in large parts of Western Europe, while keeping the predictions in the United States more conservative[20,21].

Exhibit 41: Countries and Territories with Reported All-time Temperature Records Broken or Tied in 2023



Data: Yale Climate Connections

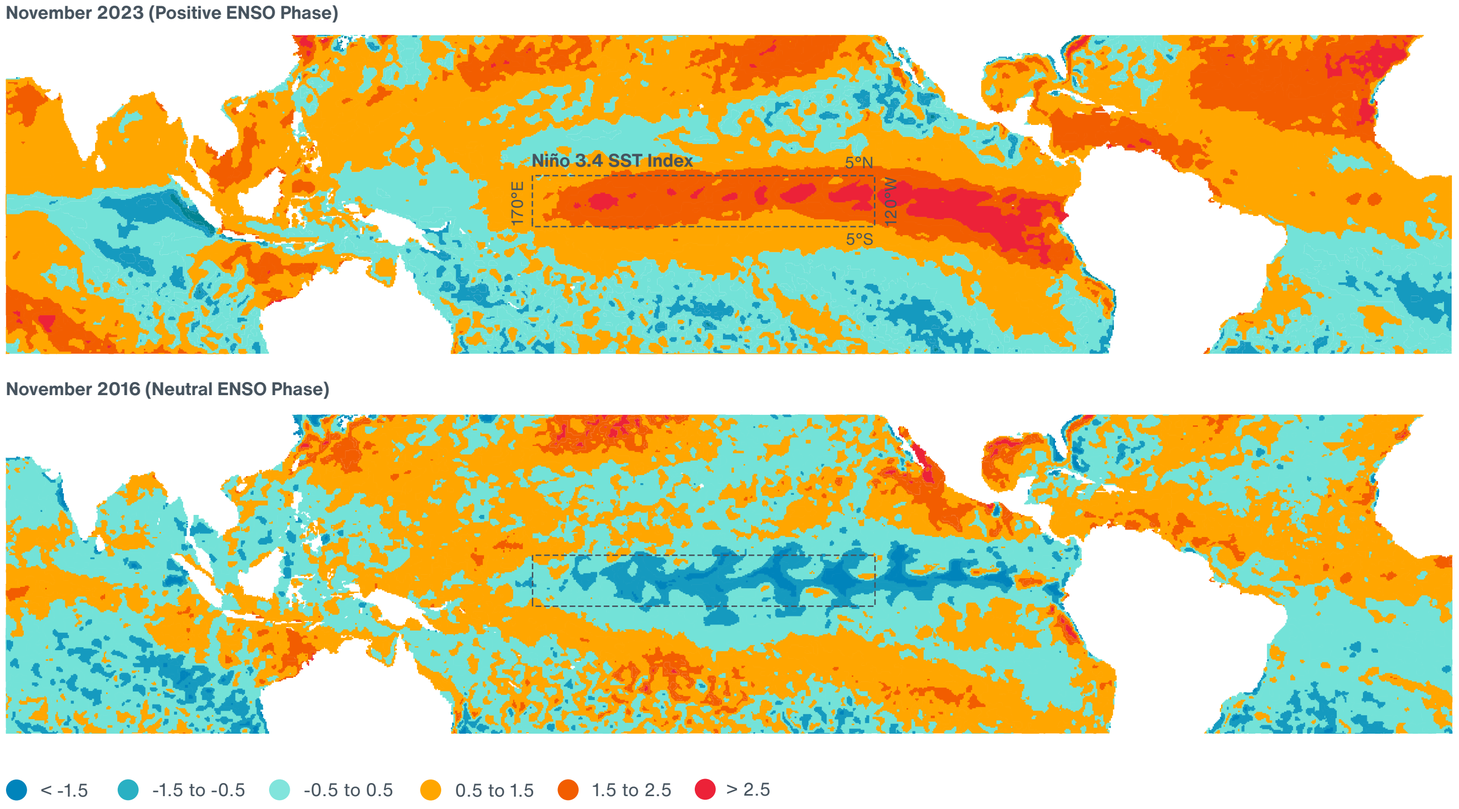
In 2023, 24 countries and territories broke or tied their previous maximum temperature records. Notably, China set the highest national record with 52.2 °C on July 16. All records in the near-tropics of Southeast Asia and Central Africa occurred between mid-April and late May when local heatwaves took place. Three European records, as well as one from North Africa, were broken at the peak of the summer during the Mediterranean heatwave. South American and Caribbean records were broken between July and mid-October.

How does the World Meteorological Organization verify temperature records? After contacting the national meteorological service responsible for taking the alleged records, the WMO will ask to obtain the raw data. This includes the exact location of the reading, the equipment used, its calibration and the regional weather conditions at the time. During a multi-month evaluation process by the international scientific community, a decision is made whether to include or reject the temperature record.

El Niño Likely to Affect Global Weather Patterns

Abnormally high sea surface temperatures in the Pacific Ocean can disrupt the Earth's climate system, leading to more unpredictable weather and property damage.

Exhibit 42: Temperature Anomalies in November 2023 and 2016 in the Equatorial Pacific (1971-2000 Baseline)

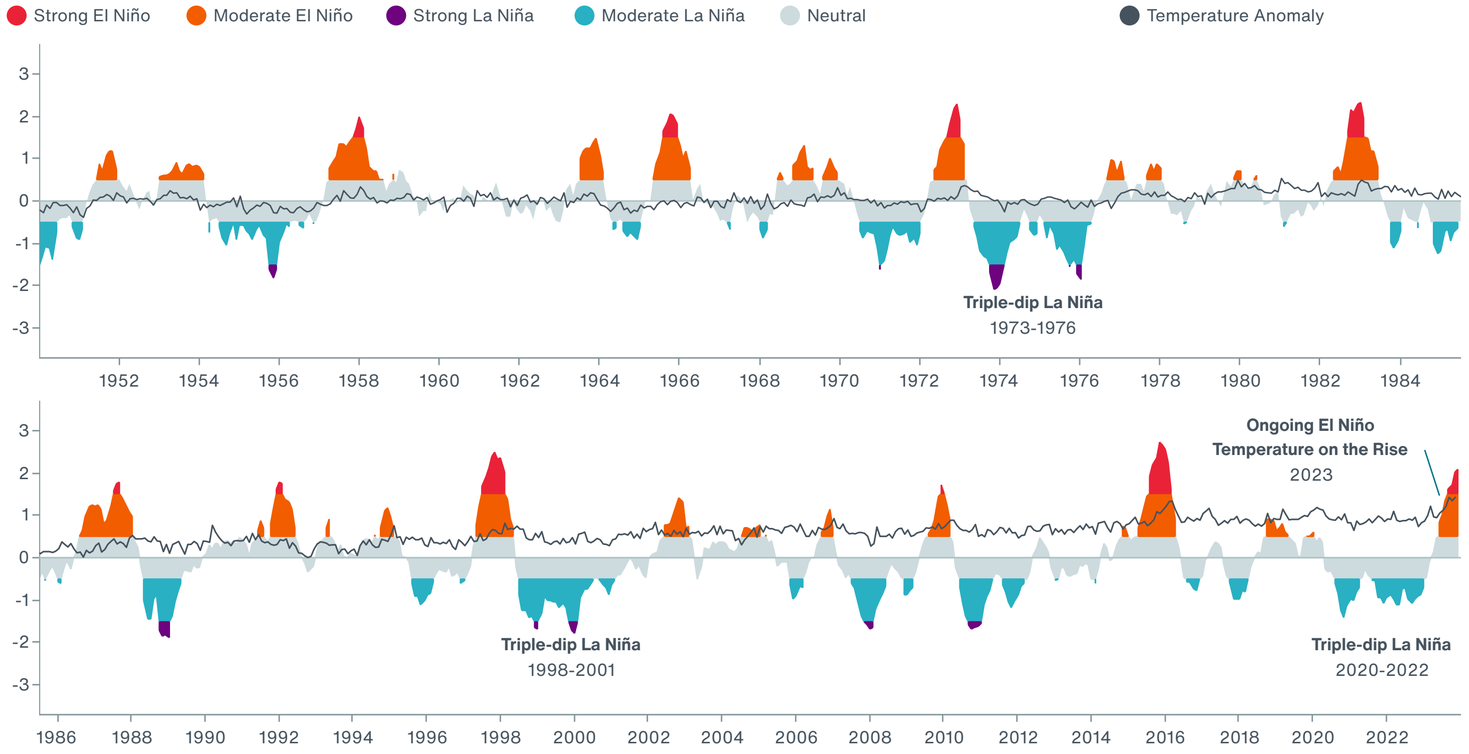


Data: NOAA

In contrast to the 2020–2022 period, when the El Niño Southern Oscillation (ENSO) was dominated by a triple La Niña phase, the ENSO Index reached positive values as early as March 2023. Since then, unusually high temperatures (>0.5 °C above normal), have prevailed in the tropical Pacific. This allowed El Niño to develop from late 2023 onwards[22]. As a result, the ongoing 2023/24 winter season is being associated with many extreme events.

The behavior of the ENSO, and the estimation of associated losses, is incredibly difficult to predict. Growing scientific evidence suggests that the accuracy of ENSO predictions depend on the timing of used meteorological data. In fact, reliability increases when forecasts are calculated from conditions at the onset of El Niño or La Niña instead of those typical of normal[23]. This indicates that with expected increase in the frequency of these phenomena in the future[24], more simulations will become available and loss estimates could improve.

Exhibit 43: Monthly ENSO Phase Based on Oceanic Niño 3.4 Index And Temperature Anomaly (˚C)



Data: Climate Prediction Center / NOAA

What is the Niño 3.4 Index? The index calculates the average monthly temperatures in the tropical Pacific Ocean (5 °S – 5 °N and 170 °E – 120 °W) and compares these values a long-term mean (1991-2020). The anomalies in sea surface temperatures are then used to calculate this index, which is a three-month running average. If the value is above 0.5, indicating an anomalously warm sea surface temperatures (SST), an El Niño occurs. If values are less than -0.5, indicating a colder SST, a La Niña develops.

By having this index plotted on the longer timescale, it is possible to understand the variability of ENSO phases. It also shows that El Niño and La Niña conditions occur in semi-regular cycles: every 2-7 years. Generally, El Niño occurs more frequently, which is also expected in the future. This will be particularly relevant, as this warm phase is often associated with warmer global temperatures, as seen in 2023.

Note that the temperature anomaly is based on the 1901-2000 period.

Making Better Investment Decisions in a Changing Climate

For investors, climate change means navigating uncertainties and understanding a wide range of potential outcomes. With efforts to limit global warming and its effects around the world gaining momentum, the role of investors as part of decarbonization efforts is evolving.

With efforts to limit global warming and its effects around the world gaining momentum, the role of investors as part of decarbonization efforts continues to evolve. In this environment, investors should consider climate change from three perspectives: protecting their portfolios against financial risks, benefiting from growth opportunities in climate solutions and determining how to have a positive impact on decarbonizing the real economy.

How to Implement Responsible Investing

While no one-size-fits-all approach exists for investors considering climate change, these five actions can help assess the best strategies based on objectives, views and circumstances:

1. Integrate climate information as part of investment process.
2. Use and understand the limitations of climate scenarios.
3. Use investment managers with the skills to seamlessly integrate climate risks and opportunities into their decisions.
4. Prioritize efforts to decarbonize the real economy over the portfolio.
5. Create positive impact by investing in carbon-intensive businesses.

Short-Term Returns Versus Long-Term Sustainability

Investors should continue to use data and analytics for climate modeling to make nearer-term risk management and portfolio optimization decisions to deliver optimal returns. Since the resolution of catastrophe models is high, following this approach provides investors with valuable insights at the individual asset level to make informed investment and divestment decisions.

In the longer term, investment opportunities will emerge as industries transition from fossil fuels to newer and cleaner technologies. Many investment-hungry industries are already pursuing decarbonization, opening the door to new opportunities for investors to actively drive a more sustainable future. However, these changes may increase exposure to new risks — and ones with potentially costly implications if not properly addressed. Without the support of sophisticated data and robust climate modeling, rapidly changing pressures can make the longer-term financial outlook more difficult to accurately forecast for investors.

Using Climate Data to Help Investors Make Better Decisions

Maintaining the best possible returns, while also navigating climate-related risks and opportunities, will undoubtedly challenge investors. Institutional investors need data, analytics and specialist expertise to help them understand different climate pathways, identify and manage physical and transition risks, and ultimately make informed decisions to protect and grow assets.

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Tim Manuel
Investment Consulting Partner, Aon Investments

Appendices

Appendix A: 2023 Global Disasters

United States

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
01/01-12/31	Drought	United States	N/A	14,000
01/04-01/10	Flooding	California	0	1,450
01/07	Severe Convective Storm	Texas	0	80
01/11-01/16	Flooding	California	0	620
01/12	Severe Convective Storm	Alabama, Georgia	11	770
01/17-01/19	Flooding	California	0	225
01/23	Winter Weather	Northeast	0	25
01/24	Severe Convective Storm	South	0	255
01/31-02/02	Winter Weather	South	8	385
02/02-02/05	Winter Weather	Northeast	1	1,850
02/07-02/09	Severe Convective Storm	Indiana, Kentucky, Ohio, Texas	0	260
02/15-02/16	Severe Convective Storm	Oklahoma, Texas	0	255
02/21-02/22	Winter Weather	California, Arizona, New Mexico	0	410
02/21-02/23	Winter Weather	Midwest, Northeast	0	330
02/23-02/25	Winter Weather	California	0	330

United States

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
02/26-02/28	Severe Convective Storm	Southwest	0	920
02/26-03/02	Winter Weather	California	0	180
03/01-03/03	Severe Convective Storm	Southeast, Midwest	13	6,200
03/09-03/12	Flooding	California, Nevada	2	255
03/13-03/15	Winter Weather	Northeast	0	220
03/13-03/15	Winter Weather	California	0	460
03/16-03/17	Severe Convective Storm	Oklahoma, Texas	0	970
03/21-03/23	Severe Convective Storm	California	5	510
03/23-03/28	Severe Convective Storm	Southeast	23	2,650
03/31-04/01	Severe Convective Storm	Midwest, Plains, Southeast	37	5,500
04/02-04/03	Severe Convective Storm	Texas	0	140
04/03-04/07	Severe Convective Storm	Southwest, Southeast, Midwest	5	2,850
04/12-04/14	Flooding	Florida	0	1,100
04/14-04/17	Severe Convective Storm	Southeast, Midwest	0	1,250
04/18-04/22	Severe Convective Storm	Southwest, Midwest	0	2,950

United States

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
04/25-04/27	Severe Convective Storm	Oklahoma, Florida, Texas	0	1,250
04/28-04/30	Severe Convective Storm	Southeast, Northeast	0	1,150
05/02-05/09	Severe Convective Storm	Plains, Southeast, Midwest	0	2,550
05/09-05/14	Severe Convective Storm	Midwest, Plains	1	3,650
05/17-05/20	Severe Convective Storm	Texas	0	1,750
05/22-05/26	Severe Convective Storm	Texas, New Mexico, Colorado	2	760
05/23-05/30	Severe Convective Storm	West, Midwest	0	135
05/31-06/04	Severe Convective Storm	New Mexico, Oklahoma, Texas	0	200
06/05-06/08	Severe Convective Storm	Plains	0	565
06/10-06/15	Severe Convective Storm	South, Plains	3	3,950
06/15-06/16	Severe Convective Storm	Michigan, Ohio	0	755
06/15-06/20	Severe Convective Storm	Midwest, Southeast	5	3,800
06/15-08/31	Heatwave	South, Southeast	147	N/A
06/21-06/26	Severe Convective Storm	Plains, Southeast	7	5,350
06/26-07/02	Severe Convective Storm	Midwest, Plains, SE, NE	1	2,200

United States

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
07/03-07/08	Severe Convective Storm	Plains	0	755
07/05-07/10	Severe Convective Storm	Midwest, Northeast	0	630
07/09-07/18	Flooding	Northeast	5	1,500
07/10-07/13	Flooding	Plains, Midwest	0	1,800
07/14-07/19	Severe Convective Storm	Plains, Midwest	0	1,250
07/16-07/20	Flooding	Midwest, Southeast	0	100
07/19-07/20	Severe Convective Storm	Colorado	0	225
07/19-07/21	Severe Convective Storm	Southeast	1	1,750
07/26	Severe Convective Storm	Arizona	0	140
07/26-07/30	Severe Convective Storm	Midwest, Northeast	0	1,600
08/03-08/09	Severe Convective Storm	Midwest, Northeast, Southeast	3	1,750
08/08-08/17	Wildfire	Hawaii	100	5,500
08/10-08/15	Severe Convective Storm	Nationwide	1	2,000
08/17-08/22	Hurricane Hilary	West, Southwest	0	675
08/18-08/26	Wildfire	Washington	1	550

United States

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
08/23-08/25	Severe Convective Storm	Michigan, Ohio	0	1,000
08/24-08/28	Severe Convective Storm	Midwest, Northeast, Southeast	5	100
08/27-08/31	Hurricane Idalia	Southeast	2	3,500
08/31-09/03	Severe Convective Storm	Arizona, New Mexico	0	300
09/07-09/13	Flooding	Northeast	0	1,000
09/08-09/09	Severe Convective Storm	Texas	0	100
09/12-09/14	Severe Convective Storm	Arizona, Texas	0	200
09/14-09/17	Hurricane Lee	Northeast	2	50
09/21-09/25	Severe Convective Storm	Plains, Midwest	0	1,900
09/22-09/25	Tropical Storm Ophelia	Northeast	0	450
09/26-09/27	Severe Convective Storm	Kentucky, Missouri	2	375
09/28-09/29	Flooding	New York, New Jersey, Connecticut	0	1,000
10/02-10/05	Severe Convective Storm	Plains, Midwest	0	650
10/23	Wildfire	Louisiana	7	Millions
10/23-10/24	Severe Convective Storm	Minnesota, Wisconsin	0	325

United States

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
10/24-10/26	Severe Convective Storm	Texas	0	125
11/14-11/16	Flooding	Florida	0	260
11/24-11/29	Winter Weather	Midwest, Northeast	4	Millions
12/04-12/06	Flooding	Northwest	2	50
12/09-12/11	Severe Convective Storm	Southeast, Northeast	6	650
12/16-12/19	Flooding	Northeast, Southeast	7	1,300
12/20-12/24	Flooding	California	0	300
12/25-12/26	Winter Weather	Plains, Upper Midwest	1	50

North America (Non-U.S.)

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
02/02-02/05	Winter Weather	Canada	2	195
03/31-04/01	Severe Convective Storm	Canada	0	35
04/05-04/06	Winter Weather	Canada	0	345
05/01-06/30	Alberta Wildfires	Canada	0	305
05/01-10/31	Flooding	Guatemala	67	10
05/28-06/04	Tantallon Wildfire	Canada	0	270
05/28-06/13	Wildfire	Canada	0	40
06/02-06/04	Flooding	Haiti	51	Millions
06/15-08/31	Heatwave	Mexico	249	N/A
06/18-06/20	Flooding	Canada	0	45
06/25-06/26	Severe Convective Storm	Canada	0	35
07/01	Severe Convective Storm	Canada	0	85
07/09-07/11	Flooding	Canada	0	35
07/10-07/13	SCS and Flooding	Canada	0	250
07/15	Severe Convective Storm	Canada	0	155

North America (Non-U.S.)

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
07/19-07/21	Severe Convective Storm	Canada	0	100
07/21-07/22	Flooding	Canada	3	255
07/24-07/26	Severe Convective Storm	Canada	0	50
07/26-07/30	Severe Convective Storm	Canada	0	65
08/03-08/09	Severe Convective Storm	Canada	0	140
08/05	Flooding	Canada	0	30
08/10-08/15	Flooding	Canada	0	80
08/13-09/16	Hay River Wildfire	Canada	0	40
08/15-09/21	Kelowna Wildfire	Canada	0	465
08/16-09/06	Behchoko Wildfire	Canada	0	25
08/18-09/30	Bush Creek Wildfire	Canada	0	235
08/23-08/25	Severe Convective Storm	Canada	1	145
08/23-08/24	Hurricane Franklin	Dominican Republic, Haiti	2	90
08/24-08/28	Severe Convective Storm	Canada	0	215
09/14-09/17	Hurricane Lee	Canada, Bermuda	0	30

North America (Non-U.S.)

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
10/06-10/08	Flooding	Canada	0	40
10/10-10/11	Hurricane Lidia	Mexico	3	10s of millions
10/21-10/23	Hurricane Norma	Mexico	3	50
10/25-10/26	Hurricane Otis	Mexico	52	15,300
10/29-11/01	Tropical Storm Pilar	San Salvador, Honduras	4	45
11/17-11/18	Flooding	Caribbean	32	605
12/16-12/19	Flooding	Canada	0	55

South America

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
01/01-01/12	Flooding	Brazil	10	140
01/01-06/30	Drought	Brazil, Argentina, Uruguay	N/A	15,300
01/01-04/15	Flooding	Ecuador	30	205
01/17-01/18	Flooding	Brazil	5	10
02/01-03/06	Wildfire	Chile	26	900
02/01-03/15	Heatwave	Argentina	N/A	N/A
02/05-02/08	Flooding	Peru, Bolivia	38	Millions
02/15-02/22	Flooding	Brazil, Paraguay	65	30
03/01-12/31	Drought	Brazil	N/A	2,500
03/08-03/11	Storm Yaku	Peru	6	705
03/08-03/12	Flooding	Brazil	0	95
03/16-03/21	Flooding	Brazil	10	50
03/18	Earthquake	Ecuador, Peru	18	100
03/23-03/25	Flooding	Brazil	0	20
03/26	Landslide	Ecuador	65	Millions

South America

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
04/10-04/14	Flooding	Peru	25	305
06/01-06/04	Flooding	Ecuador	0	Millions
06/15-06/16	Flooding	Brazil	16	205
06/23-06/28	Flooding	Chile	2	765
07/01-10/31	Flooding	Colombia	41	Millions
07/07-07/10	Flooding	Brazil	1	80
07/18	Landslide	Colombia	15	Negligible
08/17-08/29	Flooding	Chile	3	1,100
09/01-09/14	Flooding	Brazil, Argentina	49	705
09/23-09/27	Flooding	Brazil	0	40
10/01-12/31	Drought	Brazil	N/A	95
10/03-10/13	Flooding	Brazil	2	1,200
10/16-10/23	Flooding	Brazil	0	100
10/26-11/03	Flooding	Central South America	7	250
11/17-11/20	Flooding	Brazil	1	235

South America

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
12/08	Flooding	Brazil	2	10
12/10-12/15	Flooding	Bolivia	14	Millions
12/16-12/17	Severe Convective Storm	Argentina	15	125
12/26-12/29	Severe Convective Storm	Brazil, Argentina	0	Millions

Europe

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
01/01	Flooding	Spain, Portugal	0	25
01/14-01/15	Windstorm Frederic	Western Europe	0	25
01/16	Windstorm Gerard (Gero)	Western Europe	0	110
01/16-01/17	Windstorm Fien (Harto)	Western Europe	1	65
01/17-01/22	Flooding	Balkans	2	30
02/01	Windstorm Oleg	Germany, Czech Republic, Poland	0	30
02/03-02/04	Windstorm Pit	Central Europe	0	55
02/04-02/05	Winter Weather	Austria, Italy, Switzerland	11	Negligible
02/07-02/10	Windstorm	Northern Europe	0	15
02/08-02/10	Medicane Helios	Malta, Italy	0	145
02/17-02/18	Windstorm Otto	Western, Northern and Central Europe	0	75
02/26-02/27	Winter Weather	Western and Southeastern Europe	0	15
02/27-02/28	Windstorm Juliette	Spain	0	10
03/01-09/30	Drought	Spain	N/A	5,550
03/08-03/13	Windstorm Larisa	Western and Central Europe	0	10

Europe

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
03/25-03/26	Windstorm Khusru	France, Central Europe	0	10
03/27-04/06	Winter Weather	Austria	0	55
03/29-04/15	Wildfire	Spain	0	160
03/31	Windstorm Mathis	Western Europe	2	175
04/12	Windstorm Noa	Western Europe	0	45
04/27	Landslide and Flooding	Norway	0	120
04/29	Severe Convective Storm	Spain	0	65
05/01-06/15	Severe Convective Storm	Spain	0	120
05/01-08/10	Wildfire	Italy	2	50
05/01-08/10	Wildfire	Portugal	0	10
05/01-09/30	Drought	France	N/A	1,500
05/01-10/31	Drought	Austria	N/A	210
05/05-05/07	Severe Convective Storm	Central Europe	0	65
05/13-05/17	Flooding	Central and Eastern Europe	0	25
05/13-05/17	Flooding	Italy	15	9,750

Europe

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
05/22-05/23	Flooding	Western and Central Europe	0	60
05/23-05/24	Severe Convective Storm	Central Europe	0	Millions
05/26-05/30	Flooding	Serbia, Bosnia and Herzegovina	0	Millions
06/08-06/12	Severe Convective Storm	Western, Central and Southern Europe	2	15
06/14-06/17	Flooding	Southern and Southeastern Europe	2	70
06/16	Earthquake	France	0	445
06/18-06/22	Severe Convective Storm	Western and Central Europe	1	1,400
06/23-06/26	Severe Convective Storm	Central and Southeastern Europe	3	50
06/29-06/30	Severe Convective Storm	Spain, France	0	Millions
07/01-07/31	Wildfire	Greece	0	1,600
07/03-07/06	Severe Convective Storm	Italy	0	255
07/05	Windstorm Poly	Western and Central Europe	2	105
07/06-07/07	Severe Convective Storm	Spain, France	11	75
07/10-07/13	Severe Convective Storm	Western, Central and Southern Europe	19	1,300
07/10-07/30	Cerberus Heatwave	Southern and Southeastern Europe	5,900	N/A

Europe

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
07/16-07/19	Severe Convective Storm	Italy, France, Austria, Hungary, Slovenia, Croatia, Serbia	3	2,500
07/21-07/26	Severe Convective Storm	Italy, Austria, Germany, Switzerland, Southeastern Europe	11	5,800
07/29-07/30	Severe Convective Storm	Central and Southern Europe	0	110
08/03-08/08	Flooding	Slovenia, Austria	7	3,250
08/04-08/08	Severe Convective Storm	Central and Eastern Europe	0	65
08/06-08/08	Flooding	Norway, Sweden	0	350
08/12-08/17	Severe Convective Storm	Central Europe	0	765
08/13-08/27	Heatwave	Western, Southern and Southeastern Europe	8,300	N/A
08/14	Wildfire	France	0	Millions
08/15-08/18	Wildfire	Spain	0	160
08/18-08/31	Wildfire	Greece	20	200
08/24-08/26	Severe Convective Storm	Central and Western Europe	6	2,250
08/26-08/27	Flooding	Norway	0	20
08/28-08/30	SCS and Flooding	Central and Northern Europe	0	165
09/01-09/04	Flooding	Spain	3	370

Europe

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
09/03-09/08	Heatwave	France, United Kingdom	1,300	N/A
09/04-09/07	Flooding (Storm Daniel)	Greece, Bulgaria	21	2,350
09/11-09/13	Severe Convective Storm	Western and Central Europe	0	150
09/15-09/20	Severe Convective Storm	Western and Northern Europe	0	65
09/27-09/28	Storm Elias	Greece	0	Millions
09/27	Windstorm Agnes	Ireland, United Kingdom	0	Millions
10/03-10/04	Severe Convective Storm	Central Europe	0	Millions
10/07	Windstorm Patrick	Baltics, Poland, Belarus	1	Millions
10/09	Earthquake	Slovakia	0	20
10/11	Windstorm Ralf	Finland, Sweden, Norway	0	15
10/17-10/20	Storm Babet	Western Europe	6	565
10/20-10/23	Windstorm Aline	Germany, Denmark, Norway, Sweden	3	560
10/22-10/24	Storm Bernard	Spain	2	20
10/24-12/18	Earthquake	Iceland	0	75
10/27-10/29	Windstorm Celine	France	0	Millions

Europe

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
11/01-11/17	Flooding	France	0	1,650
11/01-11/02	Windstorm Ciarán	Western Europe	7	2,650
11/02-11/04	Flooding and Severe Convective Storm	Italy, Bulgaria, Greece	7	2,300
11/04-11/07	Windstorm Domingos	France, Spain	1	275
11/12-11/13	Windstorm Debi	United Kingdom, Ireland	0	Millions
11/16-11/19	Windstorm Frederico	France	0	40
11/22-11/23	Windstorm Niklas	Northern and Central Europe	0	50
11/26-11/28	Windstorm Bettina	Eastern Europe	23	440
12/01-12/02	Storm Ciro	France, Central Europe	0	110
12/09-12/10	Windstorm Elin and Fergus	Western Europe	0	20
12/21-12/23	Windstorm Zoltan/Pia	Western and Central Europe	0	550
12/24-12/31	Flooding	Germany, Netherlands, Czech Republic	0	950
12/27-12/28	Windstorm Gerrit/Bodo	United Kingdom, Ireland, Norway	0	35
12/31	Windstorm Geraldine	France	0	55

Middle East

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
01/18	Earthquake	Iran	0	50
01/28	Earthquake	Iran	3	255
02/06-02/20	Earthquake	Turkey, Syria	59,272	92,350
03/15	Flooding	Turkey	17	25
03/24	Earthquake	Iran	0	Millions
04/20	Severe Convective Storm	Turkey	1	Unknown
06/29-06/30	Dust Storm	Iran	0	Negligible
07/09-07/10	Flooding	Turkey	3	50
07/30-08/05	Heatwave	Iran	N/A	N/A
09/20-09/22	Dust Storm	Iran	3	Negligible
10/23-10/24	Cyclone Tej	Yemen, Oman	2	Millions
11/17-11/18	Severe Convective Storm	Turkey	9	Unknown

Africa

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
01/01-04/30	Flooding	Burundi	14	Unknown
01/01-06/30	Flooding	Ethiopia	90	Unknown
01/11-01/28	Flooding	Zambia	0	Unknown
01/17-01/28	Cyclone Cheneso	Madagascar	33	20
02/06-02/16	Flooding	Southern Africa	25	265
02/07-03/15	Flooding	Zambia	8	Millions
02/20-03/15	Cyclone Freddy	Southern Africa	1,434	665
03/22-03/25	Flooding	Somalia	22	Unknown
03/23-04/04	Flooding	Kenya, Ethiopia	41	Millions
04/01-04/12	Flooding	Central Africa	21	Unknown
04/01-04/30	Flooding	Angola	54	Millions
04/01-10/31	Flooding	Sudan	N/A	Unknown
04/02	Landslide	DRC	20	Unknown
04/24-05/03	Flooding	Rwanda, Uganda, Kenya	136	100
05/02-05/05	Flooding and Landslides	DRC	470	100

Africa

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
05/03-05/19	Flooding	Uganda	23	Unknown
05/06-05/10	Severe Convective Storm	Sierra Leone	15	Unknown
05/10	Landslide	DRC	10	Negligible
05/12-05/19	Flooding	Somalia	22	Millions
06/14-06/19	Flooding	South Africa	2	100
06/21-06/28	Flooding	Ghana	8	Unknown
07/01-08/31	Flooding	Niger	32	Unknown
07/15-07/31	Wildfire	Algeria	34	Millions
09/04-09/07	Flooding (Storm Daniel)	Libya	4,702	2,000
09/08	Earthquake	Morocco	2,960	4,000
09/17-09/19	Flooding	Nigeria, DRC	17	Unknown
09/23-09/26	Flooding	South Africa	11	Millions
10/01-12/31	Flooding	Eastern Africa	442	Unknown
10/05-10/19	Flooding	Nigeria	275	Millions
10/08	Landslide	Cameroon	28	Negligible

Africa

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
10/11-10/31	Flooding	Ghana	0	Unknown
11/13-11/25	Flooding	DRC	4	Unknown
11/30	Flooding	Angola	30	Millions
12/10-12/11	Flooding	DRC	15	Unknown
12/25-12/26	Flooding and Landslides	DRC	62	Unknown
12/27	Flooding	South Africa	21	Millions

Asia

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
01/01-12/31	Drought	China	N/A	2,700
01/01-02/25	Flooding	Philippines	55	20
01/05-01/09	Winter Weather	India	25	Negligible
01/10-01/28	Winter Weather	Afghanistan	166	Negligible
01/13-01/16	Winter Weather	China	0	40
01/17	Winter Weather	China	28	Negligible
02/01-02/28	Winter Weather	China	0	80
02/08	Flooding	Indonesia	0	Millions
03/06	Landslide	Indonesia	46	Negligible
03/11-03/14	Winter Weather	China	0	50
03/17-03/20	Severe Convective Storm	India	16	25
03/17-03/21	Flooding	Pakistan	10	Negligible
03/20-03/25	Severe Convective Storm	China	0	325
03/21	Earthquake	Afghanistan, Pakistan	19	Millions
03/24-04/06	Flooding	Pakistan	14	Millions

Asia

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
03/29-04/03	Flooding	Indonesia	2	Millions
04/01-04/30	Severe Convective Storm	China	5	235
04/01-04/30	Flooding	China	0	1,000
04/01-06/30	Heatwave	Southeastern Asia	65	N/A
04/01-06/30	Heatwave	India, Pakistan	201	N/A
04/01-10/31	Drought	India	N/A	3,600
04/01-12/31	Flooding	India	2,653	300
04/09-04/13	Tropical Depression Amang	Philippines	5	Millions
04/16	Severe Convective Storm	Cambodia	0	Millions
04/21-04/24	Severe Convective Storm	Southeastern Asia	19	Millions
04/21-04/24	Winter Weather	China	0	205
04/27	Flooding	Indonesia	0	15
04/29-05/02	Severe Convective Storm	Pakistan	12	Negligible
05/02	Earthquake	China	0	30
05/02-05/10	Flooding	China	0	95

Asia

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
05/03-05/09	Flooding	Indonesia	2	20
05/05	Earthquake	Japan	1	100
05/05-05/20	Severe Convective Storm	China	4	190
05/06-05/08	Winter Weather	China	0	70
05/07-05/10	Wildfire	Russia	21	50
05/13-05/15	Cyclone Mocha	Myanmar, Bangladesh, India	466	2,300
05/15-05/16	Winter Weather	China	0	70
05/20-08/05	Heatwave	South Korea	23	N/A
05/21	Flooding	Indonesia	0	Millions
05/22-09/30	Flooding	China	370	32,150
05/23-05/24	Severe Convective Storm	Bangladesh	18	Negligible
05/23-05/31	Typhoon Mawar	Philippines, Japan, Taiwan	2	Millions
05/25-06/02	Heatwave	China	N/A	N/A
05/26	Severe Convective Storm	India	12	25
05/27	Winter Weather	Pakistan	11	Negligible

Asia

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
05/28-06/02	Flooding	Japan	5	1,350
05/31	Flooding	Indonesia	0	Millions
06/01-06/04	Landslides	China	22	Negligible
06/01-09/30	Flooding	Nepal	68	Millions
06/08-06/15	Wildfire	Kazakhstan	15	Millions
06/10	Severe Convective Storm	Pakistan	33	Millions
06/15-06/16	Cyclone Biparjoy	India, Pakistan	12	260
06/25-09/30	Flooding	Pakistan	226	Unknown
07/01-07/14	Flooding	Japan	13	510
07/01-08/10	Flooding	Vietnam	12	Millions
07/04-07/06	Severe Convective Storm	Sri Lanka	0	Millions
07/06-07/10	Severe Convective Storm	China	5	195
07/09-07/18	Flooding	South Korea	49	50
07/10-07/20	Heatwave	China	N/A	N/A
07/13-07/19	Typhoon Talim	Philippines, China, Vietnam	3	375

Asia

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
07/22-07/24	Flooding	Afghanistan	31	Unknown
07/26-08/01	Typhoon Doksuri	Philippines, Taiwan, China, Vietnam	106	2,150
07/28-08/18	Flooding	Vietnam	0	45
07/30	Severe Convective Storm	Russia	10	Millions
08/01-08/10	Flooding	Bangladesh	51	100
08/01-08/31	Severe Convective Storm	China	3	155
08/02-08/10	Typhoon Khanun	Eastern Asia	6	455
08/03	Landslide	Georgia	18	Negligible
08/06	Earthquake	China	0	35
08/11-08/17	Flooding	Russia	6	110
08/13	Landslide	Myanmar	32	Negligible
08/14-08/16	Typhoon Lan	Japan	1	500
08/26-09/03	Typhoon Saola	Eastern Asia	1	1,350
08/27	Flooding	Tajikistan	21	Unknown
09/02	Severe Convective Storm	India	12	Unknown

Asia

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
09/03-09/07	Typhoon Haikui	Philippines, Taiwan, China	3	740
09/08	Flooding	Hong Kong	0	250
09/08-09/09	Tropical Storm Yun-yeung	Japan	3	10s of millions
09/19	Severe Convective Storm	China	10	100
10/03	Earthquake	Nepal	1	10s of millions
10/04	Flooding	India	179	1,400
10/04-10/10	Typhoon Koinu	Taiwan, Philippines, China, Hong Kong	1	10s of millions
10/06	Flooding	Indonesia	1	Millions
10/07-10/28	Earthquakes	Afghanistan	1,489	100
10/08-10/13	Flooding	Myanmar	5	Unknown
10/10-10/16	Flooding	Vietnam	2	Millions
10/14-10/17	Flooding	Indonesia	0	Millions
10/17-10/19	Typhoon Sanba	China, Vietnam	2	Unknown
10/22-11/03	Severe Convective Storm	Southeastern Asia	24	Millions
10/24-12/26	Cyclone Hamoon	Bangladesh	3	250

Asia

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
11/01-11/12	Severe Convective Storm	Sri Lanka	19	Unknown
11/02	Flooding	Indonesia	0	Millions
11/03	Earthquake	Nepal	154	100
11/07-11/12	Severe Convective Storm and Flooding	China	0	15
11/07-11/16	Severe Convective Storm	Southeastern Asia	1	Unknown
11/12-11/16	Flooding	Vietnam	0	15
11/13-11/16	Flooding	Indonesia	4	Millions
11/17	Earthquake	Philippines	11	30
11/20-11/27	Flooding	Indonesia	0	Millions
11/24-11/30	Severe Convective Storm	Indonesia	0	Unknown
11/26-11/27	Severe Convective Storm	India	24	Unknown
11/30-12/11	Flooding	Indonesia	4	15
12/02-12/03	Earthquakes	Philippines	3	25
12/03	Volcano Eruption	Indonesia	23	Negligible
12/04-12/06	Cyclone Michaung	India	25	125

Asia

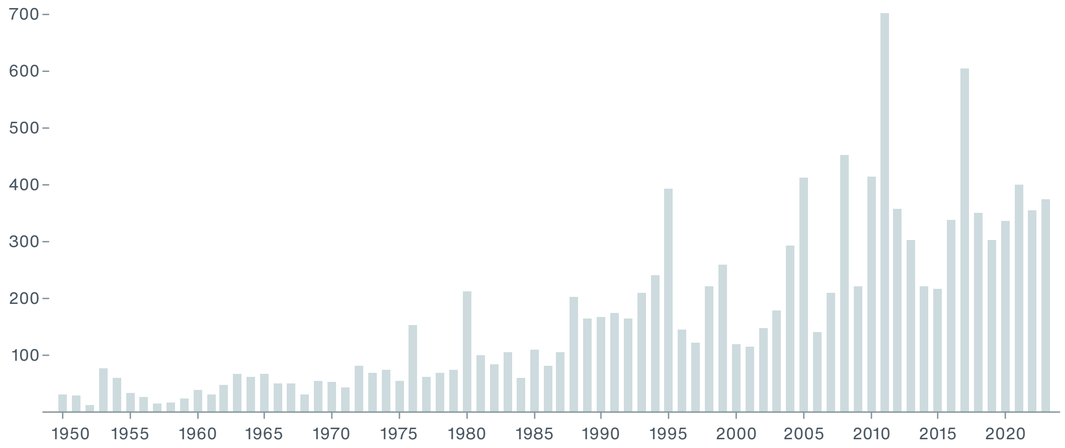
Date(s)	Event	Location	Deaths	Economic Loss ($ million)
12/11-12/25	Winter Weather	China	0	75
12/14	Earthquake	Indonesia	0	Millions
12/15-12/20	Flooding	Indonesia	0	Millions
12/18	Earthquake	China	151	1,000
12/18-12/20	Tropical Storm Jelawat	Philippines	0	Millions
12/18-18/20	Severe Convective Storm	India	10	Unknown
12/22-12/25	Flooding	Thailand, Malaysia	0	50

Oceania

Date(s)	Event	Location	Deaths	Economic Loss ($ million)
01/27-02/02	Flooding	New Zealand	4	3,400
02/12-02/17	Cyclone Gabrielle	New Zealand	11	3,950
02/21-02/28	Severe Convective Storm	New Zealand	0	20
02/28-03/05	Cyclones Judy, Kevin	Vanuatu, Solomon Islands	0	300
05/09-05/12	Flooding	New Zealand	0	50
05/23-05/31	Typhoon Mawar	Guam	2	255
05/26	Severe Convective Storm	Australia	0	245
12/13-12/18	Cyclone Jasper	Australia	0	675
12/23-12/26	Severe Convective Storm	Australia	10	625

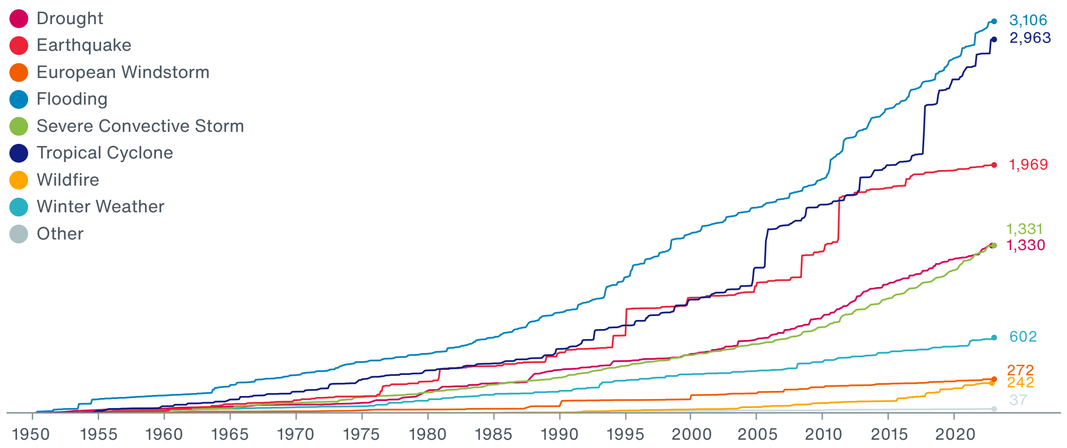
Appendix B: Long-term Natural Disaster Trends

Exhibit 44: Global Economic Losses Since 1950 (2023 $B)



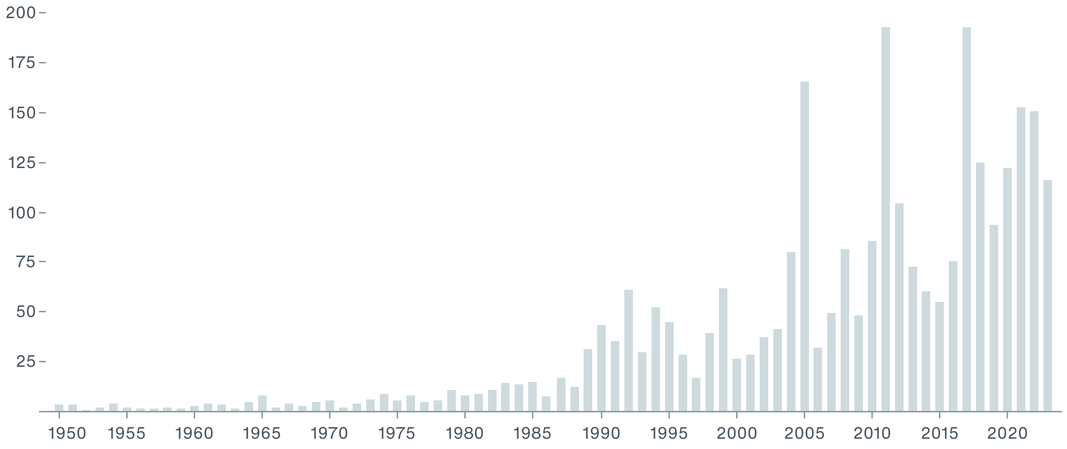
Data: Aon Catastrophe Insight

Exhibit 45: Cumulative Global Economic Losses by Peril (2023 $B)



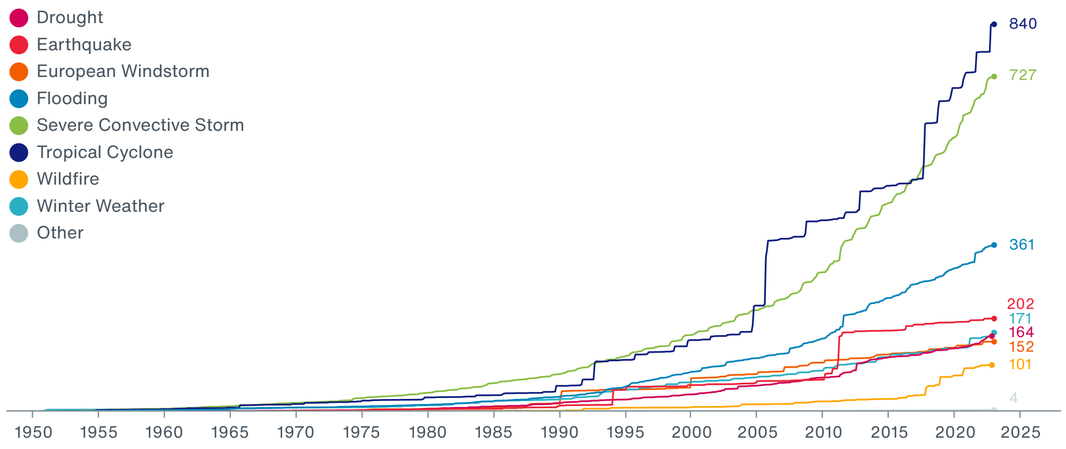
Data: Aon Catastrophe Insight

Exhibit 46: Global Insured Losses from Natural Disasters (2023 $B)



Data: Aon Catastrophe Insight

Exhibit 47: Cumulative Global Insured Losses by Peril (2023 $B)



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 (in 2023 $) 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.

2023 disaster events that ranked among the Top 10 costliest events are highlighted.

Exhibit 48: Top 10 Costliest Global Economic Loss Events (1900-2023)

Date(s)	Event	Location	Economic Loss (Nominal $ billion)	Economic Loss (2023 $ billion)
March 11, 2011	Tohoku EQ/Tsunami	Japan	235	324
January 17, 1995	Great Hanshin EQ	Japan	103	210
August 2005	Hurricane Katrina	United States	125	196
May 12, 2008	Sichuan Earthquake	China	122	173
August 2017	Hurricane Harvey	United States	125	157
September 2017	Hurricane Maria	Puerto Rico, Caribbean	90	112
October 2012	Hurricane Sandy	U.S., Caribbean, Canada	77	102
September 2022	Hurricane Ian	U.S., Cuba	96	99
September 2017	Hurricane Irma	U.S., Caribbean	77	96
January 17, 1994	Northridge EQ	United States	44	93

Exhibit 49: Top 10 Costliest Global Insured Loss Events (1900-2023)

Date(s)	Event	Location	Insured Loss (Nominal $ billion)	Insured Loss (2023 $ billion)
August 2005	Hurricane Katrina	United States	65	102
September 2022	Hurricane Ian	U.S., Cuba	54	56
March 11, 2011	Tohoku EQ/Tsunami	Japan	35	48
September 2017	Hurricane Irma	U.S., Caribbean	33	42
August – September 2021	Hurricane Ida	U.S., Caribbean	36	41
October 2012	Hurricane Sandy	United States	30	40
August 2017	Hurricane Harvey	United States	30	38
September 2017	Hurricane Maria	Puerto Rico, Caribbean	30	37
August 1992	Hurricane Andrew	U.S., Bahamas	16	35
January 17, 1994	Northridge EQ	United States	15	32

Exhibit 50: Top 10 Costliest Tropical Cyclones: Economic Loss (1900-2023)

Date(s)	Event	Location	Economic Loss (Nominal $ billion)	Economic Loss (2023 $ billion)
August 2005	Hurricane Katrina	United States	125	196
August 2017	Hurricane Harvey	United States	125	157
September 2017	Hurricane Maria	U.S., Caribbean	90	112
October 2012	Hurricane Sandy	U.S., Caribbean	77	102
September 2022	Hurricane Ian	U.S., Cuba	96	99
September 2017	Hurricane Irma	U.S., Caribbean	77	96
August – September 2021	Hurricane Ida	U.S., Caribbean	75	85
August 1992	Hurricane Andrew	U.S., Bahamas	27	60
September 2008	Hurricane Ike	U.S., Caribbean	38	54
September 2004	Hurricane Ivan	U.S., Caribbean	27	44

Exhibit 51: Top 10 Costliest Tropical Cyclones: Insured Loss (1900-2023)

Date(s)	Event	Location	Insured Loss (Nominal $ billion)	Insured Loss (2023 $ billion)
August 2005	Hurricane Katrina	United States	65	102
September 2022	Hurricane Ian	U.S., Cuba	54	56
September 2017	Hurricane Irma	U.S., Caribbean	33	42
August – September 2021	Hurricane Ida	U.S., Caribbean	36	41
October 2012	Hurricane Sandy	U.S., Caribbean, Canada	30	40
August 2017	Hurricane Harvey	United States	30	38
September 2017	Hurricane Maria	U.S., Caribbean	30	37
August 1992	Hurricane Andrew	U.S., Caribbean	16	35
September 2008	Hurricane Ike	U.S., Caribbean	18	26
October 2005	Hurricane Wilma	U.S., Caribbean	13	19

Exhibit 52: Top 10 Costliest Severe Convective Storm Events: Economic Loss (1900-2023)

Date(s)	Event	Location	Economic Loss (Nominal $ billion)	Economic Loss (2023 $ billion)
August 2020	Midwest Derecho	United States	13.6	16.1
April 2011	2011 Super Tornado Outbreak	United States	10.2	14.0
May 2011	Joplin Tornado/SCS	United States	9.1	12.4
April 1965	Palm Sunday Outbreak	United States	1.2	11.8
April 1974	Super Outbreak 1974	United States	1.5	9.8
March 1973	United States SCS	United States	1.3	9.0
May 2003	United States SCS	United States	4.5	7.5
July 2013	Storm Andreas	Europe	5.3	6.9
April 1979	Texas Tornadoes & Flooding	United States	1.5	6.5
March 2023	**United States SCS**	**United States**	**6.1**	**6.2**

Exhibit 53: Top 10 Costliest Severe Convective Storm Events: Insured Loss (1900-2023)

Date(s)	Event	Location	Insured Loss (Nominal $ billion)	Insured Loss (2023 $ billion)
August 2020	Midwest Derecho	United States	9.2	10.9
April 2011	2011 Super Outbreak	United States	7.6	10.3
May 2011	Joplin Tornado/SCS	United States	7.0	9.5
May 2003	United States SCS	United States	3.3	5.5
July 2013	Storm Andreas	Europe	3.8	5.0
March 2023	**United States SCS**	**United States**	**4.9**	**5.0**
March-April 2023	**Tornado Outbreak**	**United States, Canada**	**4.3**	**4.4**
May 2019	United States SCS	United States	3.7	4.4
June 2023	**United States SCS**	**United States**	**4.3**	**4.3**
April 2016	San Antonio Hailstorm	United States	3.2	4.1

Exhibit 54: Top 10 Costliest Floods: Economic Loss (1900-2023)

Date(s)	Event	Location	Economic Loss (Nominal $ billion)	Economic Loss (2023 $ billion)
June-December 2011	Thailand Floods	Thailand	45	61
June-September 1998	Yangtze River Floods	China	31	59
July-August 2010	Yangtze River Floods	China	39	55
July 2021	Western Europe Floods (Bernd)	Europe	46	52
June-August 1993	Mississippi Floods	United States	21	45
June-September 2020	China Seasonal Floods	China	35	42
July-August 1931	Yangtze River Floods	China	2.0	41
June-August 1953	Japan Floods	Japan	3.2	37
May-August 2016	Yangtze River Floods	China	28	36
June – September 2021	China Seasonal Floods	China	31	35

Exhibit 55: Top 10 Costliest Earthquakes: Economic Loss (1900-2023)

Date(s)	Event	Location	Economic Loss (Nominal $ billion)	Economic Loss (2023 $ billion)
March 11, 2011	Tohoku EQ/Tsunami	Japan	235	324
January 16, 1995	Great Hanshin EQ	Japan	103	210
May 12, 2008	Sichuan Earthquake	China	122	173
January 17, 1994	Northridge EQ	United States	44	93
February 6, 2023	**Turkey & Syria EQ**	**Turkey, Syria**	**90**	**92**
November 23, 1980	Irpinia EQ	Italy	20	72
April 14, 2016	Kumamoto EQ	Japan	38	49
October 23, 2004	Chuetsu EQ	Japan	28	45
February 27, 2010	Chile EQ	Chile	30	43
December 7, 1988	Armenian EQ	Armenia (Present Day)	16	41

Exhibit 56: Top 10 Costliest Individual Wildfires: Insured Loss (1900-2023)

Date(s)	Event	Location	Insured Loss (Nominal $ billion)	Insured Loss (2023 $ billion)
November 2018	Camp Fire	United States	10.0	12.2
October 2017	Tubbs Fire	United States	8.7	10.9
November 2018	Woolsey Fire	United States	4.2	5.1
October 1991	Oakland (Tunnel) Fire	United States	1.7	3.8
October 2017	Atlas Fire	United States	3.0	3.7
May 2016	Horse Creek Fire	Canada	2.9	3.7
August 2023	**Maui / Hawaii Fire**	**United States**	**3.0**	**3.5**
September-October 2020	Glass Fire	United States	3.0	3.5
August-September 2020	CZU Complex Fire	United States	2.5	3.0
December 2017	Thomas Fire	United States	2.3	2.8

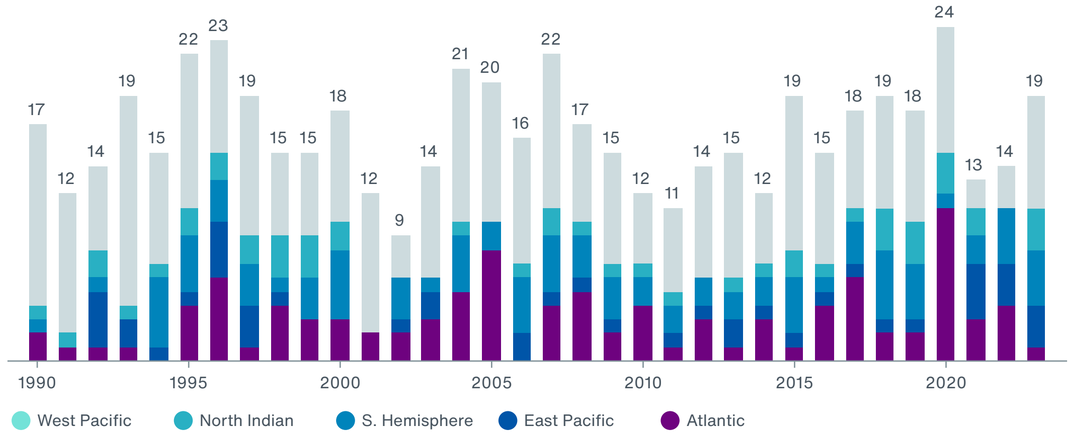
Exhibit 57: Top 10 Global Human Fatality Events in the Modern Era, Excluding DR & HW Events (1950-2023)

Date(s)	Event	Location	Economic Loss (Nominal $ billion)	Fatalities
November 12, 1970	Cyclone Bhola	Bangladesh	0.7	300,000
July 27, 1976	Tangshan EQ	China	37	242,769
July 30, 1975	Super Typhoon Nina	Taiwan, China	6.8	230,029
December 26, 2004	Indian Ocean EQ/Tsunami	Indian Ocean Basin	30	226,408
January 12, 2010	Port-au-Prince EQ	Haiti	11.4	160,000
April 1991	Cyclone Gorky	Bangladesh	4.1	139,000
May 2008	Cyclone Nargis	Myanmar	18.3	138,366
August 1971	Vietnam Floods	Vietnam	N/A	100,000
October 8, 2005	Kashmir EQ	Pakistan	10.3	88,000
May 12, 2008	Sichuan EQ	China	173	87,652

Appendix D: Global Tropical Cyclone Activity

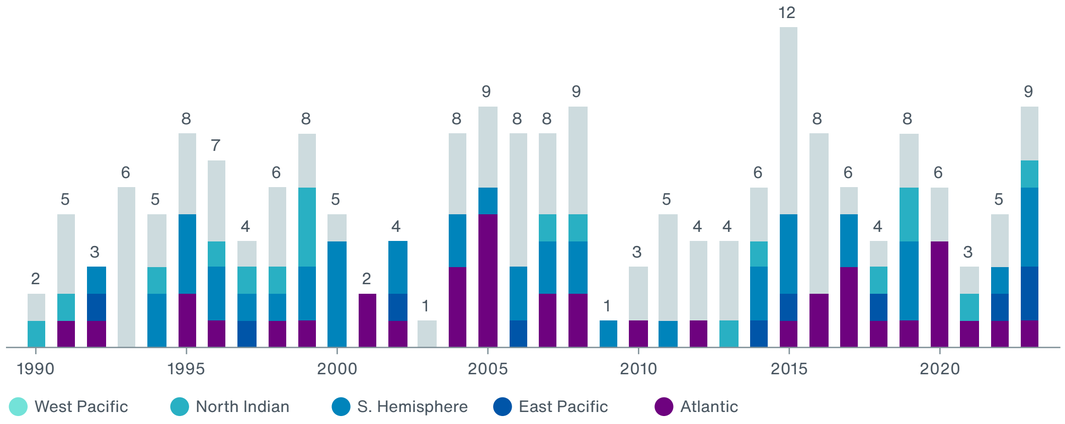
Please note that 1990 is generally considered the first year when global tropical cyclone data are best verified in every basin. Data from the Southern Hemisphere prior to 1990 is still subject to future reanalysis by official tropical cyclone agencies. While there continues to be increasing instances of costlier and more impactful landfalling tropical cyclones, there has yet to be any obvious shift in landfall trends across the globe. This suggests that losses are largely being driven by the increased levels of population and exposure along vulnerable coastal locations. However, as thoroughly referenced elsewhere in this report, emerging trends indicate that tropical cyclones are intensifying at a faster rate and reaching the highest intensity levels for longer periods and near the point of landfall. This is a concerning trend and one that portends to greater future losses for the peril.

Exhibit 58: Global Cat 1+ Tropical Cyclone Landfalls



Data: NOAA

Exhibit 59: Global Cat 3+ Tropical Cyclone Landfalls

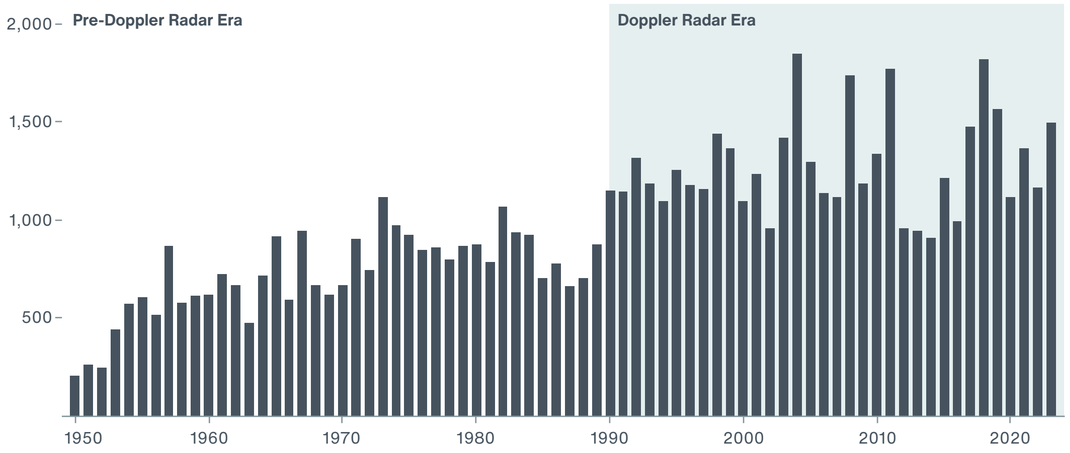


Data: NOAA

Appendix E: United States Storm Report Data

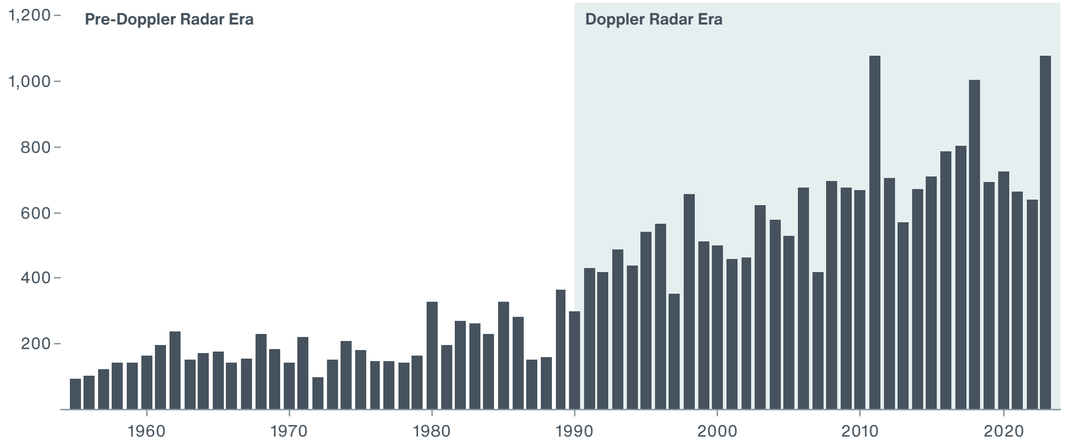
Given the increased cost of severe weather-related damage in the United States during the past decade for insurers, the following is a number of tornado and large hail reports. The data comes via NOAA's Storm Prediction Center. Please note that data prior to 1990 are often considered incomplete given 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 2023 is to be considered preliminary.

Exhibit 60: U.S. EF0+ Tornado Reports Since 1950



Data: NOAA

Exhibit 61: U.S. 2+ Inches Hail Reports Since 1955

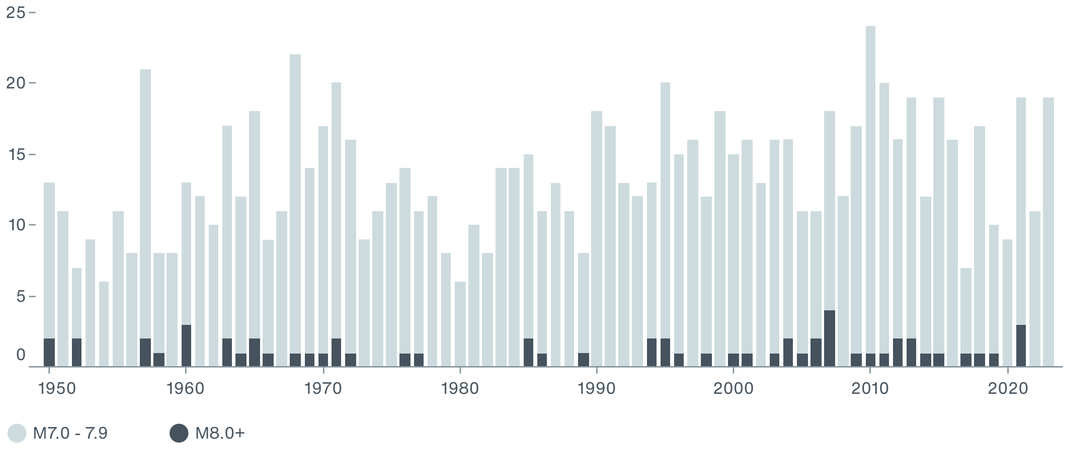


Data: NOAA

Appendix F: Global Earthquakes

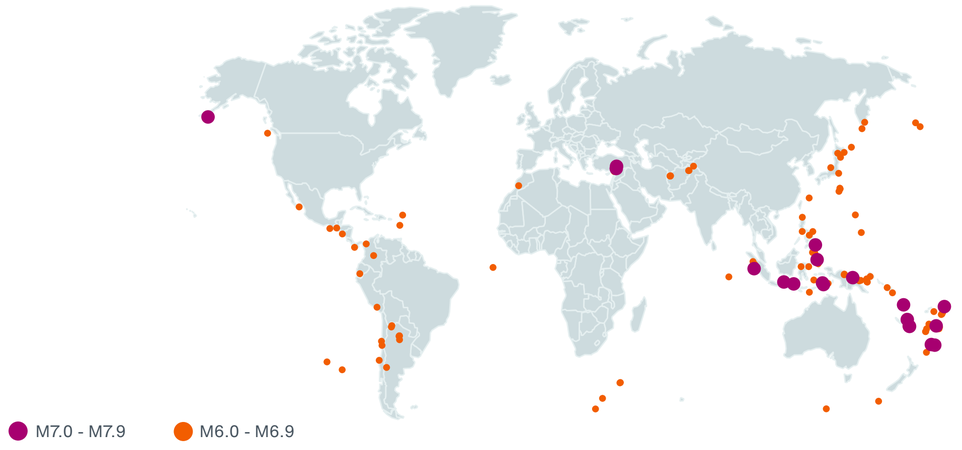
Based on the historical data from the United States Geological Survey (USGS), 2023 saw at least 148 earthquakes with magnitudes of 6.0 or greater. Overall earthquake activity does not often show large fluctuations on an annual basis. This is especially true given the extensive network of global seismograph stations that has led to an improved and more robust dataset in recent decades.

Exhibit 62: Global M7.0+ Earthquakes Since 1950



Data: USGS

Exhibit 63: Global M6.0+ Earthquakes in 2023

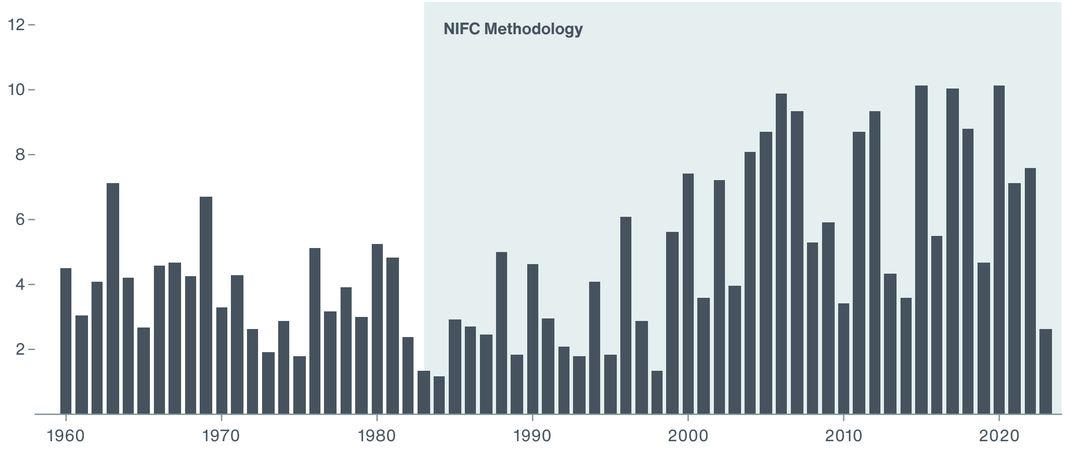


Data: USGS

Appendix G: United States Wildfire Data

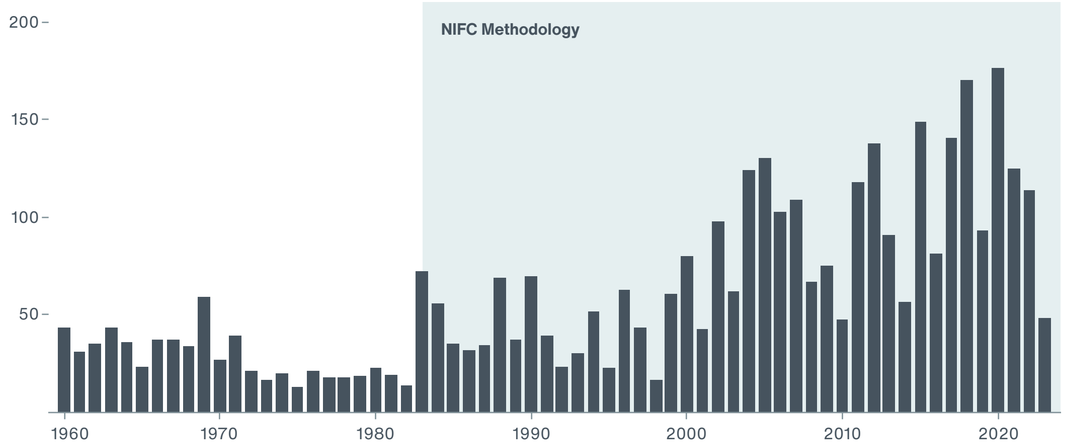
The following wildfire data in the United States is provided by the National Interagency Fire Center (NIFC), which began compiling statistics under its current methodology in 1983. Previous data was collected by the National Interagency Coordination Center (NICC) from 1960 to 1982 but used a different methodology. It is not advised to compare pre-1983 data to post-1983 data given these different data collection methods.

Exhibit 64: Area Burned by Wildfires in the United States Since 1960 (million acres)



Data: NIFC, NICC

Exhibit 65: Area Burned per Fire in United States Wildfires Since 1960 (acres)



Data: NIFC, NICC

Additional Report Details

All financial loss totals are in US dollars ($) unless noted otherwise.

DR = Drought, EQ = Earthquake, WS = EU Windstorm, FL = Flooding, SCS = Severe Convective Storm, TC = Tropical Cyclone, WF = Wildfire, WW = Winter Weather, VL = Volcano, HW = Heatwave, LS = Landslide

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 public and private insurance entities 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. Damage estimates are determined based on various public media sources, including news websites, publications from insurance companies, financial institution press releases, and official government agencies. Economic loss totals are separate from any available insured loss estimates. An insured loss is the portion of the economic loss covered by public or private insurance entities. In rare instances, specific events may include modeled loss estimates determined from utilizing Impact Forecasting's suite of catastrophe model products.

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