JANUARY 2024

Gallagher Re

# Natural Catastrophe and Climate Report: 2023

Data, Insights, and Perspective

# Foreword

# Welcome to Gallagher Re's 2023 Natural Catastrophe and Climate Report

In 2023, the estimated total economic costs of direct physical damage and net-loss business interruption from global natural perils were USD357 billion. The private insurance market and public insurance entities covered an estimated USD123 billion of that total. This marks the fourth consecutive year that nominal insured losses have topped USD100 billion, and the sixth year out of the last seven. A new normal.

We continue to witness an increase in the severity and high-impact frequency of natural catastrophe events. These effects bring multifaceted and complex challenges for the (re)insurance industry as the importance of blending today's view of risk with the anticipated downstream implications of tomorrow grows more critical.

In this report, we aim to help readers give greater thought to how topics such as climate change, insurability, and other socioeconomic factors are leading to new emerging areas of risk. We face growing requirements in our industry to take a leading role in identifying the direct and indirect risks that pose challenges to the private sector, governmental entities, emergency managers, and elsewhere.

We are also introducing a new feature into the report that offers unique insight and emerging research from colleagues across the Gallagher family and from some of our academic partners via the Gallagher Research Centre. This outside expertise helps to further contextualize how important topics involving natural catastrophe risk, climate change, and an evolving regulatory environment are affecting our clients and other key private and public sector stakeholders.

**Readers of this report can expect to:**

- Explore global and regional catastrophe peril and loss drivers
- Learn which regions are facing changing loss patterns
- Identify the role of climate change and how it is influencing the decisions of the (re)insurance industry
- Better understand how global regulatory demands and climate disclosure requirements are evolving

At Gallagher Re, we provide dedicated analytical, product, and practice support to help our clients quantify, understand, and more thoughtfully develop strategies to better assess their natural catastrophe risk. This includes integration and collaboration across teams such as Global Catastrophe Analytics, the Public Sector, Parametric & Climate Resilience Solutions group, or the Gallagher Research Centre. We recognize that blending physical risk solutions with emerging transition risk solutions (such as the carbon market) is key to meeting the world's ambitious climate targets.

We thank you for your support and look forward to helping you navigate your way through the inevitable challenges that Mother Nature will bring in 2024.

**Steve Bowen**

Chief Science Officer

Gallagher Re

# Executive Summary

2023 was a year marked by the dominance of so-called "secondary" perils and continued record-setting weather/climate phenomena that were enhanced by the arrival of a strong El Niño phase of the El Niño-Southern Oscillation (ENSO). The estimated direct economic cost of natural hazards was USD357 billion. An estimated USD123 billion of that total was covered by the private insurance market (USD110 billion) and public insurance entities (USD13 billion). This meant that the portion of event costs not covered by insurance — known as the protection gap — stood at 66%, or USD234 billion. The most expensive event on an economic basis was the February earthquake sequence in Turkey. That event caused an economic cost of USD46.2 billion, with private and public insurance entities covering USD6.1 billion of the cost. There were a record 66 individual billion-dollar economic loss events. The 34 individual billion-dollar insured loss events also set an annual record.

The economic cost solely from weather and climate events in 2023, which excludes losses from earthquakes or other non-atmospheric-driven events, was an estimated USD301 billion, of which insurers covered an estimated USD116 billion. A significant portion of the insured losses (57%) resulted from the severe convective storm (SCS) peril. The SCS peril topped USD71 billion in 2023, of which USD60 billion occurred in the US alone. This set a record for insurers globally and in the US.

We continue to witness the ongoing influence of climate change on the behavior of individual events and broader weather patterns around the world. While there are varying differences in how climate change affects each peril hazard and the regional expectations of how climate change will directly impact specific areas of the world, the fingerprints are now regularly evident. The need to implement proper planning and investment strategies, in addition to meeting net-zero carbon emission or portfolio transition targets to limit further atmospheric and oceanic warming, grows more urgent. This is especially true as 2023 officially became the warmest year on record in the modern era dating to 1850, and scientists believe it was the warmest year in the last 125,000 years. Keeping the world on a path to meet the main goal of the Paris Agreement — limiting temperature rises to within 1.5°C of the pre-industrial baseline (1850–1900) — remains a challenging endeavor but not yet completely out of reach.

If we do not meaningfully change the status quo and subsequently reverse the growth of carbon dioxide emissions, then we should no longer be surprised at the consequences of more extreme weather/climate events that are influenced by warmer ocean waters and a destabilized atmosphere. The insurance industry has an important role in mitigating climate risk, but it must be done in conjunction with other private and public market stakeholders.

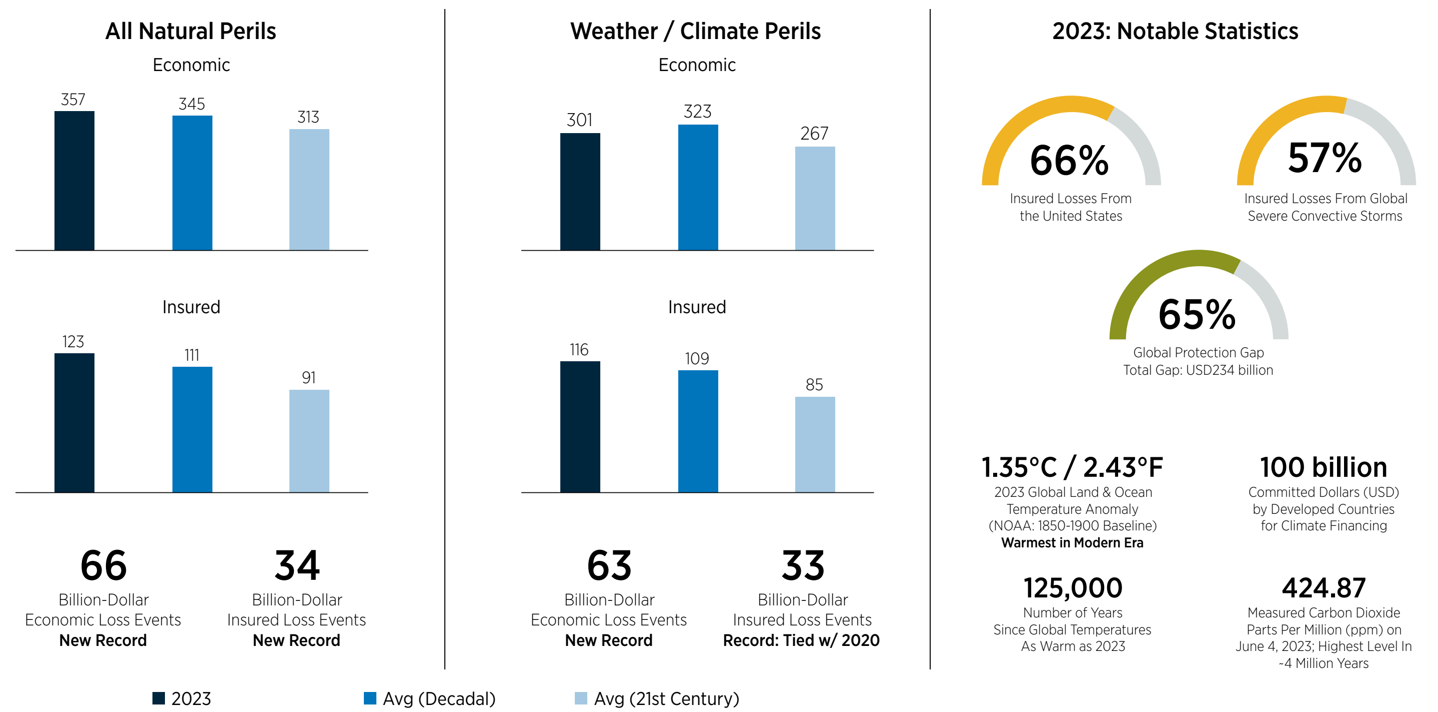



**Figure 1:** Overview of 2023 catastrophe activity and additional notable statistics | **Data and Graphic:** Gallagher Re

All monetary values in this report are in US dollars (USD) unless stated otherwise. Historical losses have been adjusted to today's dollars using the US Consumer Price Index and an index factor of construction and labor costs.

# Newsworthy Natural Catastrophe and Climate Topics of 2023

# “Secondary” Perils Dominate Annual Catastrophe Losses

Growing calls to shift away from framing perils as either “primary” or “secondary” as the global implications of climate change accelerate commitments to tackle critical carbon reduction targets.

The annual costs of natural catastrophes continue to rise for the (re)insurance industry, with 2023 marking the fourth consecutive year with nominal losses exceeding USD100 billion and the sixth year since 2017 to achieve the feat. What was unique about 2023 was reaching the USD100 billion insured loss threshold without a few dominant events driving annual loss costs. 2023 became the first year where global insured losses topped USD100 billion without a singular event causing more than USD10 billion for the industry. It was also the first year since 2017 in which no event topped that total. With 2023 crossing the USD100 billion total through the aggregation of a high volume of highly impactful “secondary” peril events, it suggests a narrative shift in how the (re)insurance industry accounts for the “new normal” of high loss years without a major market event — such as a landfalling US hurricane.

This occurs at a time when the usage of the words “primary” or “secondary” to define individual perils is increasingly called into question. In the last 10-15 years, nearly every major peril (tropical cyclone, severe convective storm, earthquake, flooding, wildfire, winter weather, and drought) has now recorded an individual insured loss event that has topped USD10 billion. The lone exception is the European windstorm peril. Exposure management is an essential piece to underwriting and portfolio analysis, and with the continued growth of new populations/exposed properties into high-risk areas for natural perils and increased climate change influence, it is quickly changing the view of risk in many parts of the world for all perils. While the largest tropical cyclone or earthquake (“primary”) events will continue to drive the highest individual loss costs, we can no longer dismiss the potential significance of every other (“secondary”) peril occurrence. This is especially true for some insurance carriers, who now view “secondary” perils as their primary portfolio risk.

Moving forward, a more appropriate way to bucket perils is likely to be the usage of “peak” or “non-peak”. Such discussion is likely to be more relevant for individual companies to identify which perils are “peak” to their portfolio. For companies with a more regional risk focus versus one with a global view, this can also allow a more targeted and effective way to communicate an internal or external portfolio risk profile.

**United States SCS costs dominate global insured losses**

The United States recorded an unprecedented volume of high-dollar-loss severe convective storm (SCS) events in 2023. This resulted in an estimated record USD60 billion in insured losses from the peril. The overall economic cost was estimated to be USD78 billion. This included 23 individual billion-dollar economic loss events and 20 billion-dollar insured loss events solely from thunderstorm outbreaks. At least nine of the SCS events resulted in a multi-billion-dollar insured loss. Hail continued to be a dominant driver of loss costs as the sub-peril typically accounts for 50% to 80% of SCS claims in any given year. The US has now recorded more than USD25 billion in annual insured SCS losses in six of the past seven years, as the peril continues to erode primary insurance carrier earnings. Insured SCS losses in the US have shown a 9.6% annual rate of growth since 2000, largely driven by an expansion of suburban and exurban population areas that increase the potential of incurred damage.

The country saw above-average losses despite a relatively benign 2023 Atlantic hurricane season for US landfalls. Idalia struck the Florida panhandle as a Category 3 storm, but the economic damage was much less than initially feared (USD3.6 billion). Intense drought conditions affected major agricultural-producing states in the Plains and Midwest which left an estimated economic damage bill of nearly USD15 billion. Roughly half of that cost resulted in indemnity payouts from the USDA’s Risk Management Agency’s crop insurance program. A historic wildfire on Hawaii’s Maui Island resulted in extensive damage in the city of Lahaina, with total direct economic costs estimated at up to USD6 billion. The USD3.8 billion in insured costs left it as Hawaii’s second-costliest natural disaster event on record, only behind 1992’s Hurricane Iniki.

### Consequential global events drive protection gap

The costliest individual event of 2023 occurred in Turkey. A sequence of powerful earthquakes in February, including the M7.8 main shock, brought catastrophic damage to southern Turkey and northern Syria. At least 59,292 people were killed. The World Bank estimated that direct physical damage costs in Turkey were as high as USD41 billion, and an additional USD5.1 billion in incurred damage in Syria. Public and private insurance entities covered USD6.1 billion of the total. Another consequential earthquake struck Morocco in September. The M6.8 tremor left at least 2,960 people dead and resulted in an estimated USD7 billion in economic damage. Insured costs were estimated near USD500 million, of which a sizeable portion was covered by a parametric insurance scheme placed by Gallagher Re.

Typhoon Doksuri and its remnants led to extensive flooding in China, Taiwan, and the Philippines, which became the costliest weather/climate event of the year. The economic cost was estimated at USD18.5 billion. Hurricane Otis underwent explosive rapid intensification that saw the storm reach Category 5 intensity upon landfall in Acapulco, Mexico. The storm left USD15 billion in direct economic costs, with up to USD4.0 billion covered by insurers. Other billion-dollar economic storms included Cyclone Gabrielle (New Zealand), Cyclone Mocha (Myanmar, Bangladesh, India), Hurricane Hilary (Mexico, US), and Cyclone Michuang (India).

The influence of El Niño prompted consequential flooding and drought events in South America (Brazil, Argentina, Uruguay, Chile), Europe (Greece, Libya, Italy, Spain), Asia (China, Japan), and Oceania (New Zealand). The most notable European windstorm event was Storm Ciarán (Emir), which cost insurers USD2.2 billion, where impacts were most significant in France and Italy. The combination of anomalous heat and prolonged drought conditions aided in the worst wildfire season in Canada's modern record, with 18.5 million hectares (45.7 million acres) of land burned. Consequential summer wildfires also impacted Greece and Chile.

### COP28 brings critical commitment to fossil fuel transition

The 28th Conference of the Parties to the United Nations Framework Convention on Climate Change (COP28) took place in Dubai in December, with governments under pressure to find global consensus on the phasing-out of fossil fuels. A "global stocktake" report was published ahead of the event, providing an update on how the world is progressing in meeting climate goals established by the Paris Agreement (COP21). The stocktake noted that the world is not yet on a path to keep global temperatures from exceeding the threshold of 1.5°C above the pre-industrial baseline (1850-1900). Global carbon emissions would need to peak by 2025 to have a 50% chance of limiting temperatures below 1.5°C and a 67% chance of limiting below 2.0°C. Trillions of dollars (USD) are required for investments in renewable energy transitions and appropriate mitigation/adaptation. As seen in Figure 2, clean energy investment has been trending up.

### Key takeaways from COP28

- An explicit agreement to "transition away" from fossil fuels to ensure a net-zero carbon emission balance by 2050
- A commitment to triple renewable energy capacity by 2030
- A call for a 30% reduction in methane emissions by 2030
- Initial funding commitments for the Loss and Damage Fund launched at COP27 in Egypt
- Developed countries have committed USD100 billion for climate financing

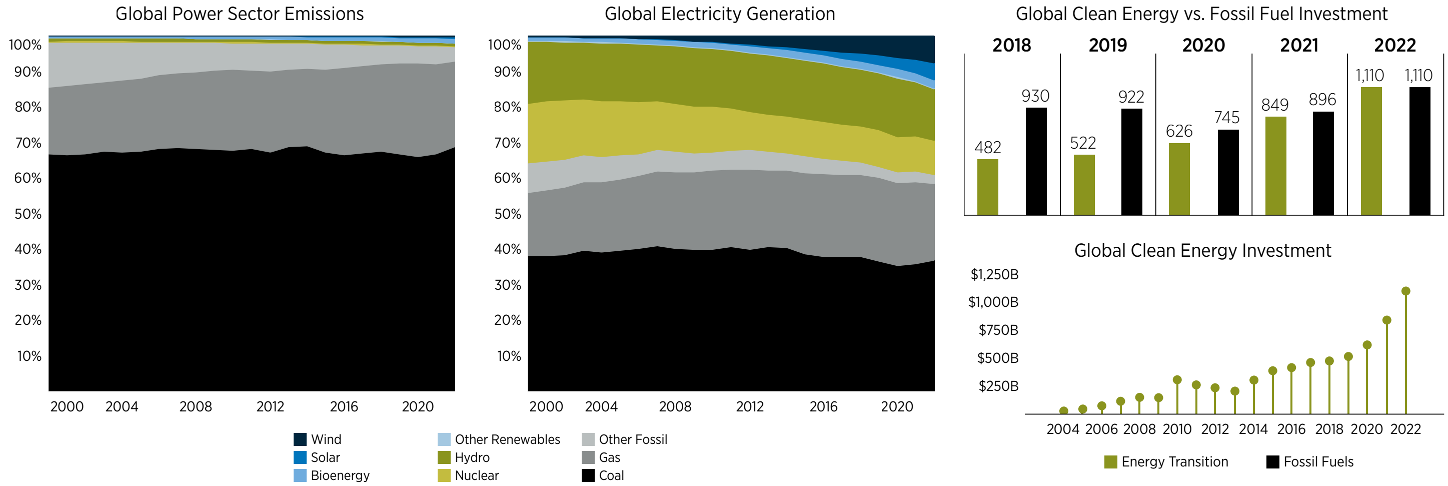



**Figure 2:** Overview of global emissions, energy output, and clean energy investment | **Data:** Ember & BloombergNEF | **Graphic:** Gallagher Re

One area that was not addressed was the establishment of regulatory guidelines for the carbon market. This was called for by Article 6.4 of the Paris Agreement, which allows the trading of carbon credits generated by emission reduction or removal of greenhouse gases from the atmosphere. The voluntary carbon market remains an important focus for private companies seeking to meet their net-zero commitments. The establishment of guaranteed financial protection during the transition process is also an evolving marketplace.

### NZIA's challenging year, and the role of carbon accounting

It was a challenging year for the Net-Zero Insurance Alliance (NZIA), as more than half of its members exited the United Nations-sponsored initiative. Just 11 companies were listed as active members on the NZIA website at the end of 2023. The departures included some of the founding members of the alliance, which called into question the viability of the NZIA moving forward. A portion of the exiting reinsurers and insurers said they were concerned by the increasing prospect of antitrust action by several state attorneys-general in the United States.

Several departing members said they would refocus their attention on developing their own tools and methodologies to quantify the carbon emissions in their underwriting and investment portfolios. Such tools are critical as companies seek to decarbonize their near- and long-term underwriting strategies, and in their efforts to achieve publicly declared net-zero emission targets.

One notable initiative announced in September 2023 was the launch of a collaboration between Lloyd's and Moody's Analytics to develop an emissions accounting solution through the Lloyd's Lab — which Gallagher Re supports. Since there is currently no standardized accounting approach, such a solution could lead to broader market adoption. As various regulatory bodies begin to mandate the reporting of greenhouse gas emissions, such as the International Sustainability Standards Board (ISSB) and Corporate Sustainability Reporting Directive (CRSD), more companies will need help to accurately report their Scope 1, 2, and 3 emissions. Scope 3 (indirect) emissions are known to be the most problematic to quantify for (re) insurers due to the limited amount of data and available company disclosures to conduct such accounting.

Despite the uncertainties surrounding NZIA's continued influence and potential issues around methodology accounting, companies appear to remain committed to their individual sustainability pledges. With some companies pledging to reach certain net-zero commitments by 2030 and others by 2050, the clock is ticking for clear progress to be seen and measured. This is particularly important as carbon accounting plays a major role in the new requirements set forth by global regulatory disclosure guidance, and companies seek to be seen as meeting the commitments of their internal goals and asks from their investors.

### Carbon accounting and new global disclosure guidance

One of the bigger tasks faced by companies in the realm of ESG reporting standards has been the lack of a consistent global approach for disclosures. For global companies, following the different disclosure requirements of multiple regions and regulators can become a laborious task. It is perhaps even more challenging for investors seeking consistent ESG-related information from various companies to assess their portfolio risk. In June 2023, the International Sustainability Standards Board (ISSB) released its first two standards, International Financial Reporting Standards (IFRS) S1 and IFRS S2. The ISSB was launched at COP26 in Glasgow and was seen as a pivotal initiative in developing a global baseline of corporate reporting standards within the IFRS framework. IFRS S1 and IFRS S2 are seen as important first steps in consolidating various reporting standards.

Per the ISSB, the standards are defined as:

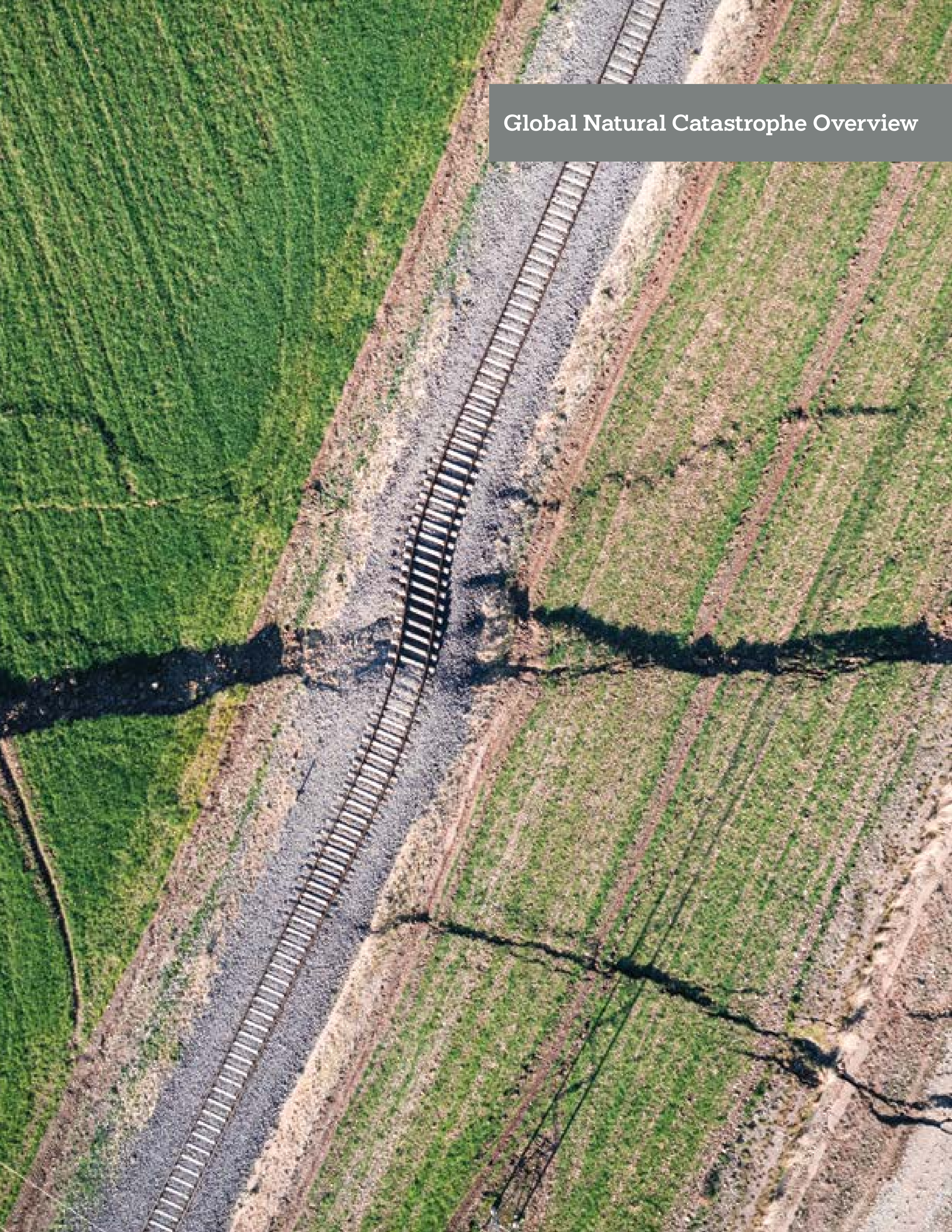
**IFRS S1:** Disclosure requirements designed to enable companies to communicate to investors the sustainability-related risks and opportunities that could affect a company's cash flow in the short, medium, and long-term. This disclosure is meant to be applied in tandem with IFRS 2.

**IFRS S2:** Disclosure requirements designed to enable companies to communicate to investors climate-related risks and opportunities. This includes information on strategy regarding physical and transition risks, the disclosure of how to meet voluntary or regulated climate targets, or results from scenario analyses to stress test how certain events could affect the business.

These standards fully incorporate the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD). They also build on work established by groups including the Sustainability Accounting Standards Board (SASB) and the Climate Disclosure Standards Board (CDSB). The implementation of these disclosures was set for January 1, 2024, with the first annual financial reports using the new ISSB standards to be released in 2025.

It will be critical for companies to be aware of their environmental ("E" in ESG) reporting standards. If the ISSB standards do take hold and become globally adopted, it will greatly improve the clarity and consistency of reporting expectations. The one important point is that there remain unique regional and country-level requirements in place. While reporting frameworks such as ISSB are critical to closing the accounting consistency gap, the disclosure requirements themselves are still different on a country-to-country basis. Regardless, if companies do not comply with the emerging and established requirements, it may increase their liability to litigation risk.

Please click here to view Gallagher's 2023 Impact Report which highlights our firm's commitment to sustainability.


Global Natural Catastrophe Overview

## Economic Losses

| Event Name | Date | Region | Countries | Economic Loss | Insured Loss |
|---|---|---|---|---|---|
| Turkey Earthquakes | Feb. 6–23 | Europe | TR, SY | 46,200 | 6,100 |
| Typhoon Doksuri | Jul. 24–31 | Asia | PH, TW, CN | 18,400 | 1,400 |
| Hurricane Otis | Oct. 24–26 | Latin America | MX | 15,100 | 4,000 |
| US Drought | Annual | United States | US | 14,900 | 7,200 |
| China Seasonal Floods | Summer | Asia | CN | 13,100 | 400 |
| Storm Daniel | Sep. 4–11 | Europe | BG, GR, LY, TR | 10,100 | 500 |
| Italy Flood/Minerva | May 12–16 | Europe | BA, HR, IT | 9,700 | 600 |
| Argentina Drought | Jan. 1–Dec. 31 | Latin America | AR | 9,200 | 300 |
| Spain Drought | Jan. 1–Dec. 31 | Europe | ES | 8,200 | 900 |
| Brazil Drought | Jan. 1–Dec. 31 | Latin America | BR | 7,200 | 200 |
| | | | **Grand Totals** | **357 billion** | **123 billion** |

**Table 1:** Top 10 costliest economic loss events of 2023 (losses listed in USD million) | **Data and Graphic:** Gallagher Re

The direct economic cost of natural catastrophes in 2023 was estimated at USD357 billion. This was 4% above the decadal (2013–2022) average of USD345 billion and 14% above the 21st century average (USD313 billion). When excluding earthquakes and other non-weather perils, the year's total was USD301 billion; or 7% lower than the decadal average (USD323 billion) but 13% higher than the average since 2000 (USD267 billion). As seen in Figure 5, there were five perils that accounted for more than 10% of the year's total economic losses: severe convective storm (27%), flooding (21%), earthquake (16%), tropical cyclone (15%), and drought (14%). There were a record 66 individual billion-dollar events in 2023; surpassing the previous record of 62 in 2010 and 2011. The 63 weather/climate-related billion-dollar events in 2023 were also a record, surpassing the 57 set in 2020. While the overall economic toll in 2023 may not have set records, it reinforced the vulnerabilities the world continues to face from costlier "non-peak" peril occurrences that are affecting larger population centers.

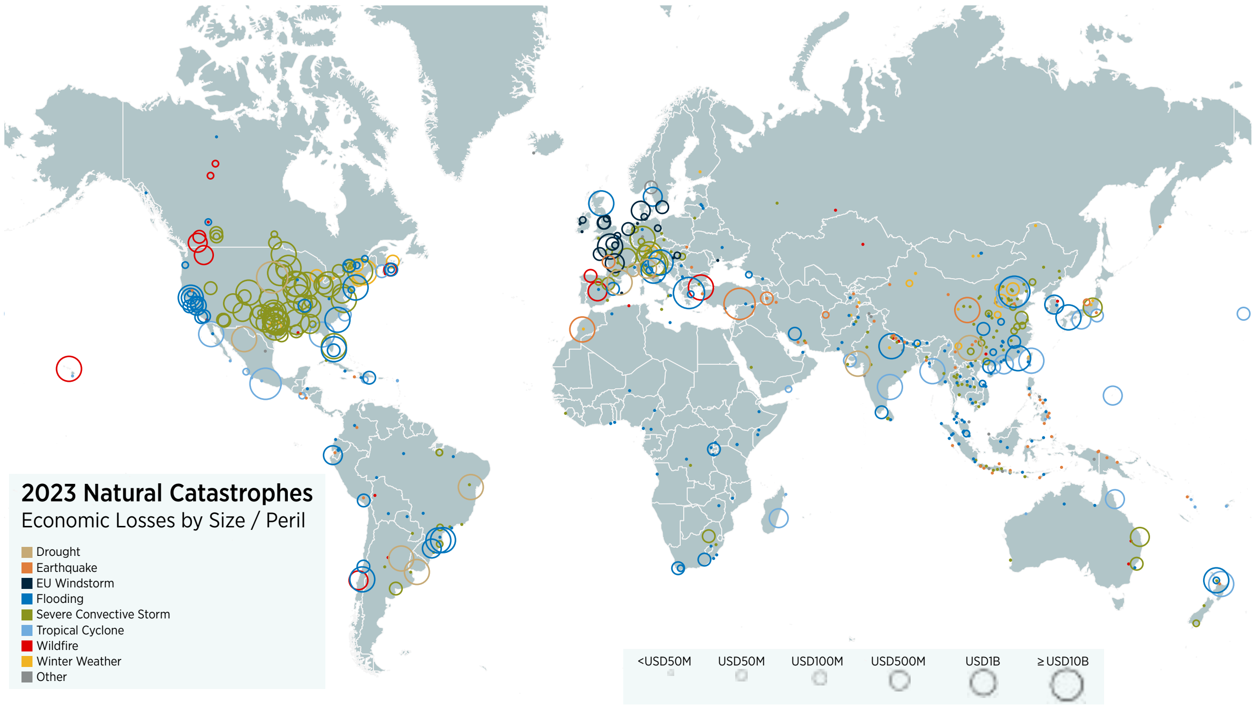



**Figure 3:** 2023 natural catastrophe map showing economic costs of events by peril | **Data and Graphic:** Gallagher Re

A 20-year view of global economic losses resulting from natural catastrophes is seen below in Figure 4. There has been a slow upward trend in direct economic costs during this time (+2.2% annual rate of growth). Perhaps most notable is the recent regularity of global losses surpassing the USD300 billion threshold; this has happened every year since 2016. The common expectation is that "primary/peak" perils should dominate annual loss costs, but the reality is that a majority of losses now tend to be driven by "secondary/non-peak" perils in most years. In 2023, non-peak perils accounted for two-thirds (67%) of loss costs — 11% higher than the 21st century average. While we still anticipate "peak" perils to drive the highest individual event losses, the continued growth of damage from "non-peak" perils is changing the way we view and plan for natural catastrophe risk. It increases the importance of analytics and catastrophe modeling to properly gauge how a combination of climate-influenced hazard changes and socioeconomic parameters is leading to higher loss potentials.

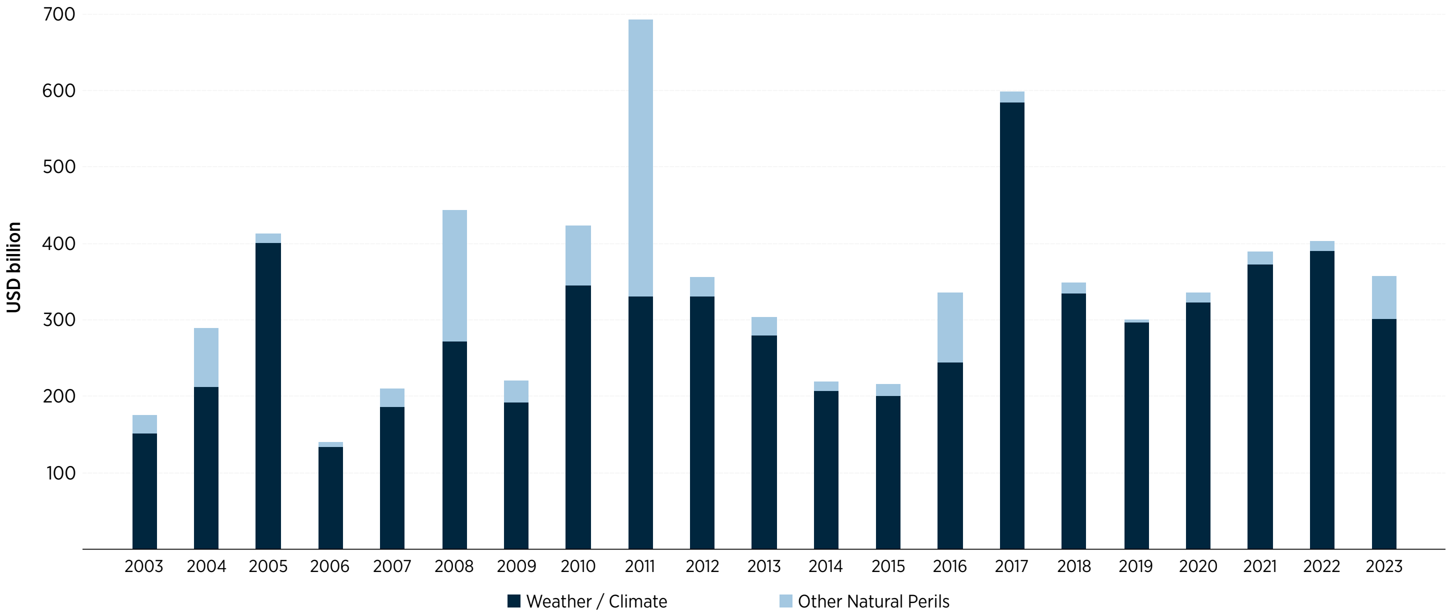
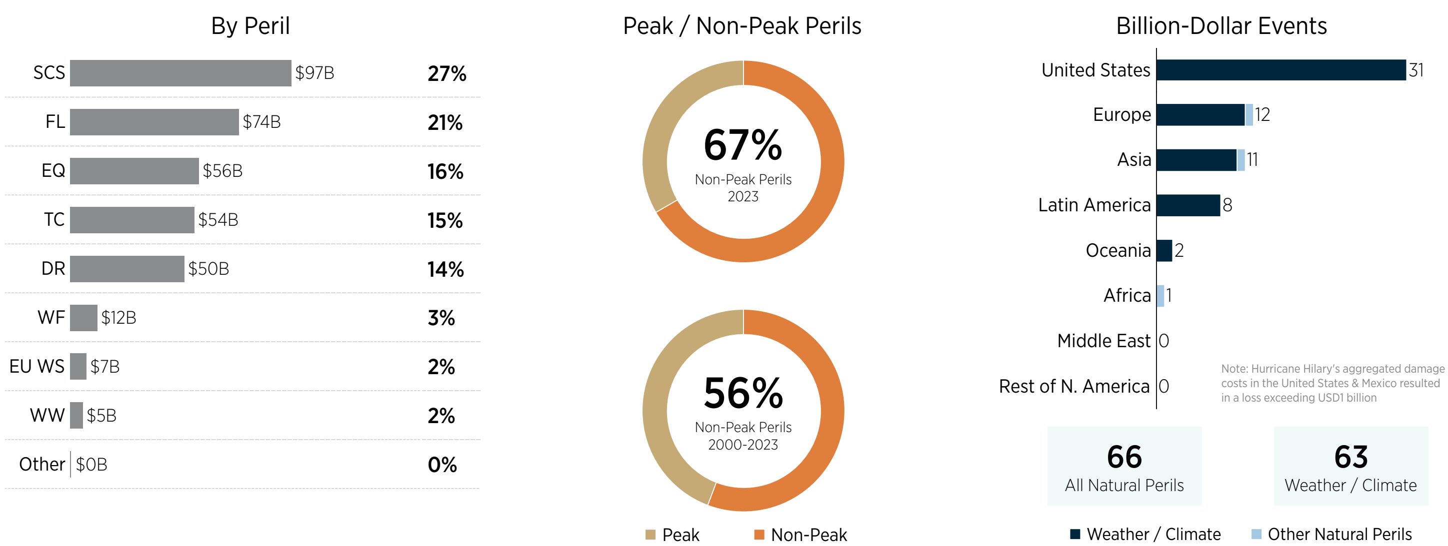



**Figure 4:** Last 20 years of annual global economic losses; historical losses adjusted using US CPI and a construction + cost of labor factor | **Data and Graphic:** Gallagher Re




**EQ:** Earthquake | **SCS:** Severe Convective Storm | **TC:** Tropical Cyclone | **WW:** Winter Weather
**DR:** Drought | **EU WS:** European Windstorm | **WF:** Wildfire | **FL:** Flooding

**Figure 5:** 2023 global economic loss statistics | **Data and Graphic:** Gallagher Re

### Insured Losses

| Event Name | Date | Region | Countries | Economic Loss | Insured Loss |
|---|---|---|---|---|---|
| US Drought | Jan. 1–Dec. 31 | United States | US | 14,900 | 7,200 |
| Turkey Earthquakes | Feb. 6–23 | Europe | TR, SY | 46,200 | 6,100 |
| Early March SCS & Wind | Mar. 1–3 | United States | US | 6,400 | 4,900 |
| Spring SCS Outbreak | Mar. 30–Apr. 1 | United States | US | 6,100 | 4,800 |
| Colorado & Texas SCS | Jun. 21–26 | United States | US | 5,700 | 4,600 |
| Hurricane Otis | Oct. 24–26 | Latin America | MX | 15,100 | 4,000 |
| Lahaina Fire | Aug. 8–10 | United States | US | 6,000 | 3,800 |
| Early June SCS Outbreak | Jun. 9–14 | United States | US | 4,300 | 3,500 |
| Mid-June SCS Outbreak | Jun. 15–20 | United States | US | 4,000 | 3,200 |
| Front Range + Midwest SCS | May 9–16 | United States | US | 3,900 | 3,100 |
| | | | **Grand Totals** | **357 billion** | **123 billion** |

**Table 2:** Top 10 costliest insured loss events of 2023 (losses listed in USD million) | **Data and Graphic:** Gallagher Re

Losses covered by private insurers or public insurance entities in 2023 were estimated at USD123 billion. This total was 11% above the decadal average (USD111 billion), but 36% higher than the 21st century average (USD91 billion). When excluding earthquakes and other non-weather perils, the year's total was USD116 billion. This was 7% above the decadal average (USD109 billion) but 37% above the average since 2000 (USD85 billion). As seen in Figure 8, the dominant peril, by far, was a severe convective storm. The peril accounted for 58% of all insured losses globally. Six of the top 10 costliest insured events of 2023 were SCS events in the US, illustrating the importance of this market to the global (re)insurance industry. There were a record 34 individual billion-dollar events in 2023, surpassing the previous record set in 2020 (32). The 32 weather/climate-related billion-dollar events tied with 2020 as the most recorded in a single year. The US accounted for 24 of the 34 billion-dollar insured events. A remarkable 11 US events resulted in a multi-billion-dollar insured loss.

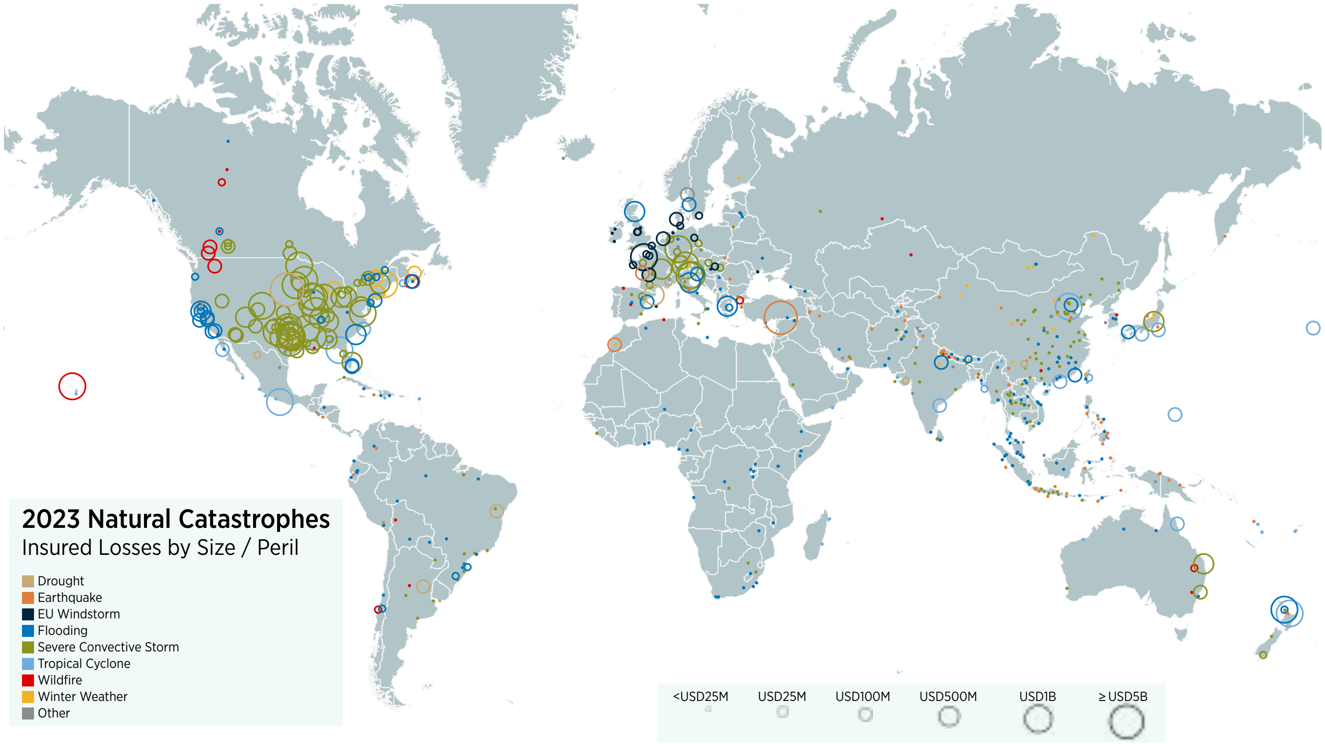



**Figure 6:** 2023 natural catastrophe map showing insured costs of events by peril | **Data and Graphic:** Gallagher Re

A 20-year view of global insured losses resulting from natural catastrophes is seen below in Figure 7. There has been an increasingly obvious upward trend in insured losses during this time (+4.3% annualized rate of growth). It is unsurprising that the annual rate of insured losses has grown at a faster pace than the overall economic total. As insurance penetration continues to expand into parts of the world with traditionally limited policy take-up, in addition to the growth of public-private partnerships to introduce parametric or cat bond solutions to guarantee financial recovery in the aftermath of an event, it is expected that more damage costs will be covered. We also see a greater portion of losses covered by government-sponsored insurance entities. Examples include the National Flood Insurance Program, or the USDA's Risk Management Agency's crop insurance program in the US, or the Turkish Catastrophe Insurance Pool (TCIP). While the progress of insurance protection is promising, there remain considerable gaps in coverage that leave many parts of the developing world highly vulnerable to catastrophe risk. The need for more guaranteed climate or natural catastrophe financing to mitigate or adapt to a more complex world of natural hazards becomes more critical by the day.

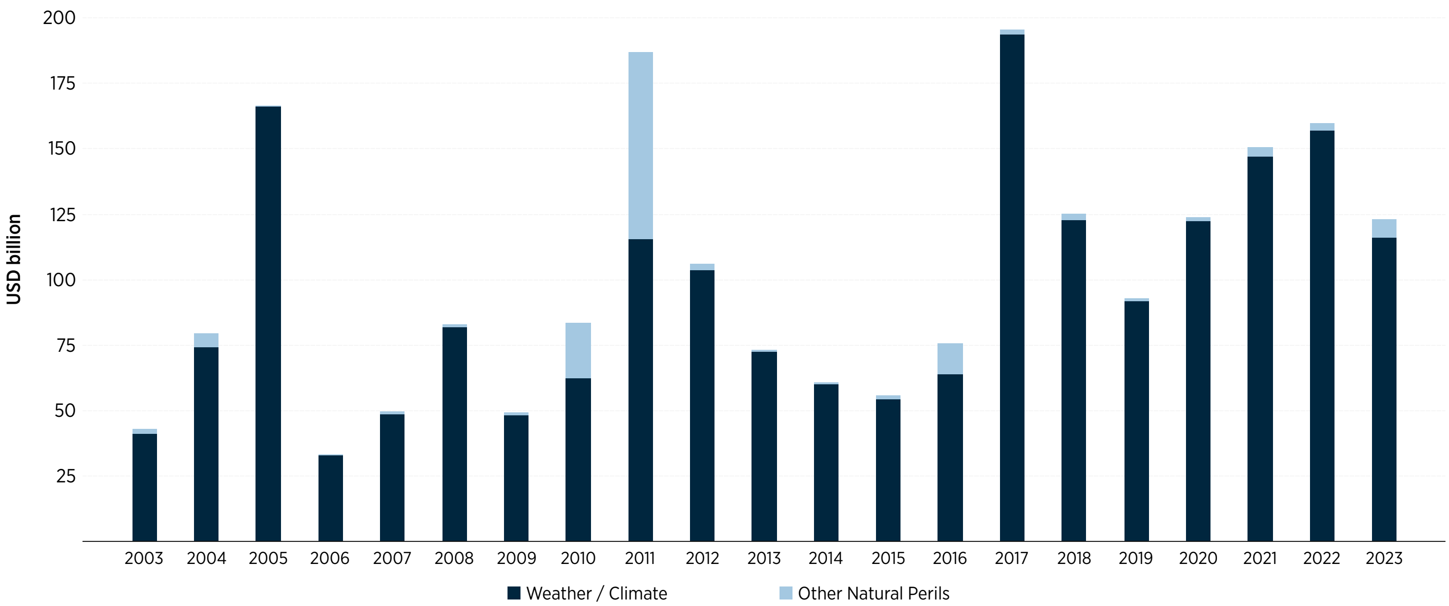
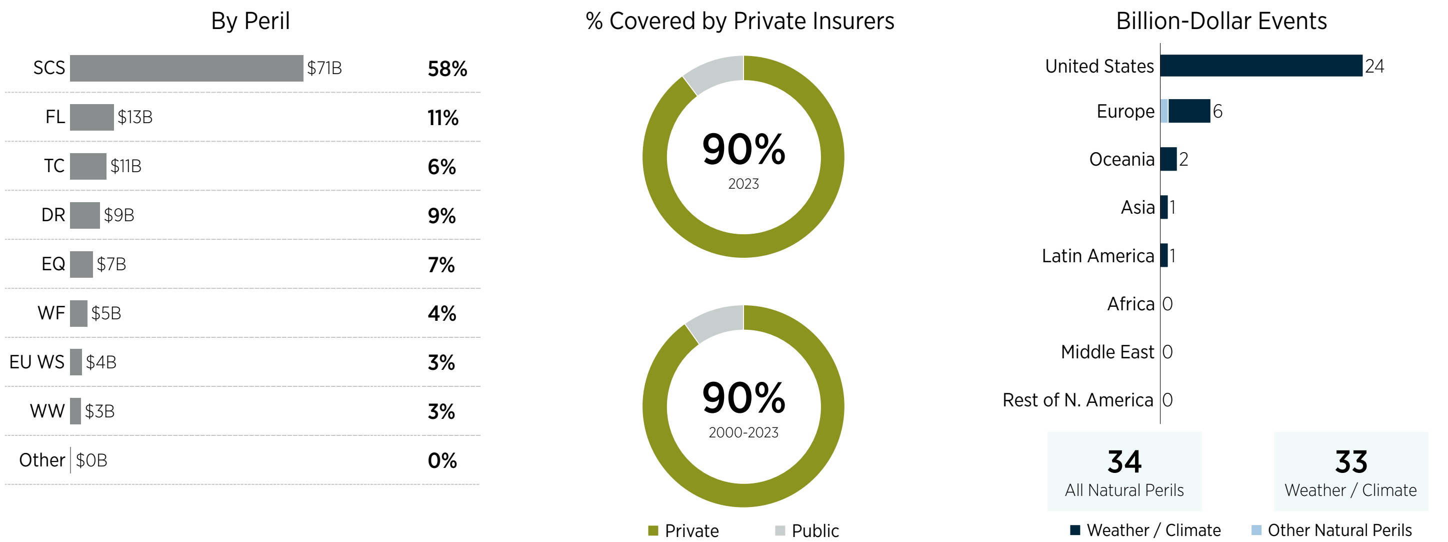



**Figure 7:** Last 20 years of annual global insured losses; historical losses adjusted using US CPI and a construction + cost of labor factor | **Data and Graphic:** Gallagher Re




| | | | |
|---|---|---|---|
| **EQ:** Earthquake | **SCS:** Severe Convective Storm | **TC:** Tropical Cyclone | **WW:** Winter Weather |
| **DR:** Drought | **EU WS:** European Windstorm | **WF:** Wildfire | **FL:** Flooding |

**Figure 8:** 2023 global insured loss statistics | **Data and Graphic:** Gallagher Re

## Regional Analysis

The United States was the dominant driver of regional losses in 2023 — both on an economic and insured loss basis. While insured losses ran higher than the recent decadal or 21st century averages, the overall economic loss was lower than the most recent decade (2013–2022). This is primarily due to there being no single large event that drove a major portion of losses, which typically occurs from a landfalling hurricane or major earthquake. The US accounted for more than two-thirds of global insured losses in 2023.

Perhaps the most surprising region was Asia, where both economic and insured losses were markedly below normal. Initial expectations in 2023 assumed higher losses resulting from such an active El Niño, but this did not materialize as the Western Pacific Typhoon Season was much quieter than forecast. Europe endured much higher than normal economic and insured losses, of which a sizable portion was attributed to the Turkey earthquake sequence. Prolific hail events in southern Europe also led to significant insured loss claims.

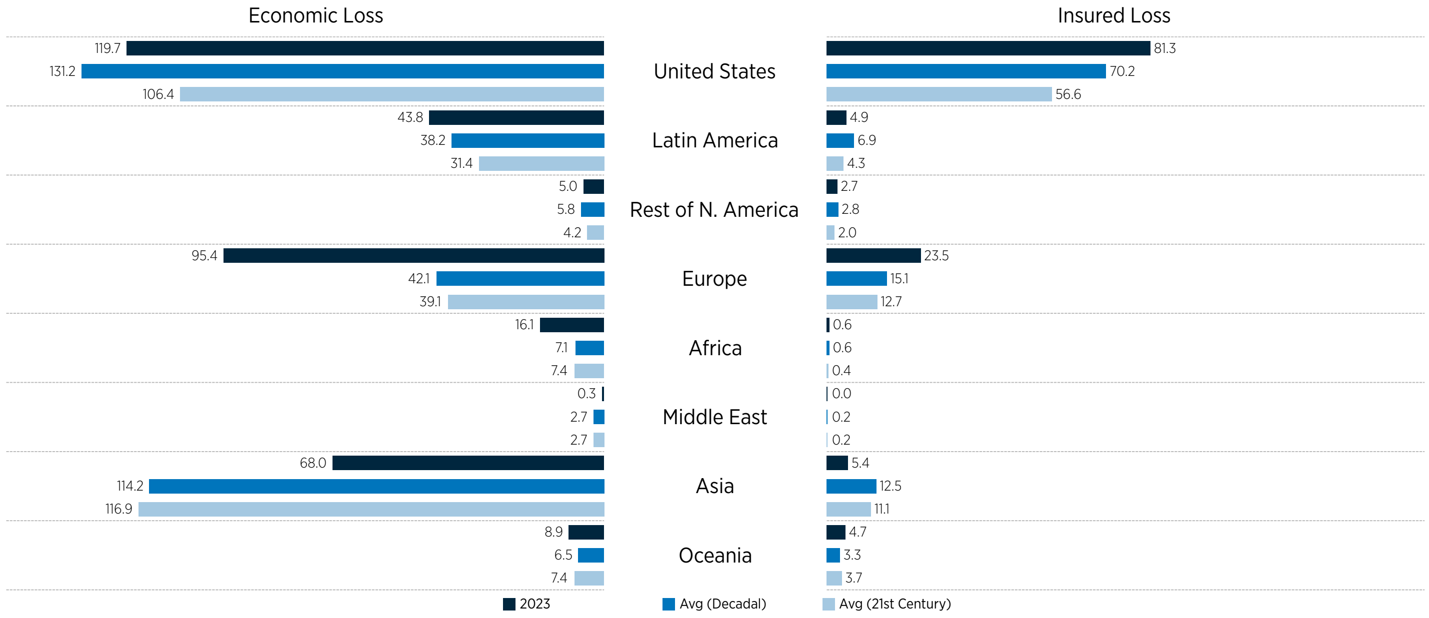



**Figure 9:** Regional economic and insured losses in 2023 versus recent history | **Data and Graphic:** Gallagher Re

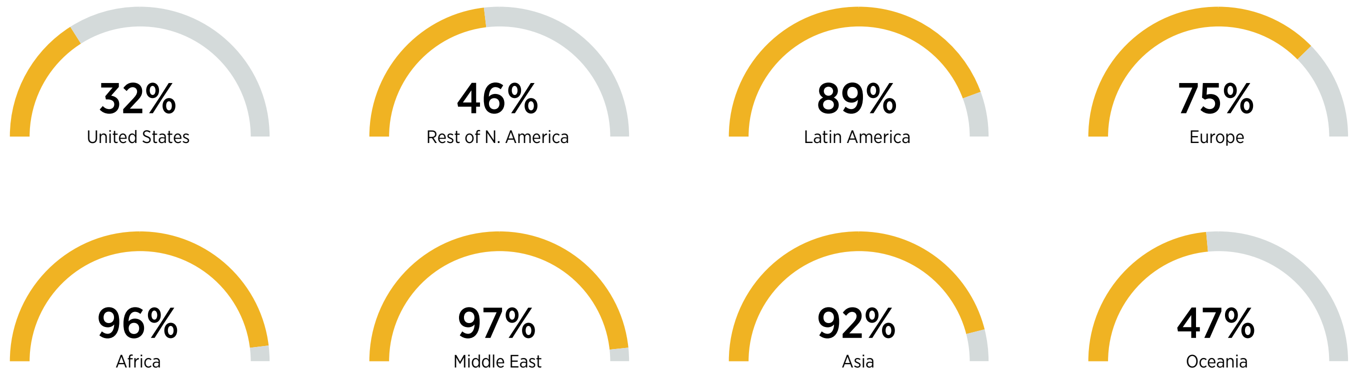



**Figure 10:** Regional protection gap in 2023 | **Data and Graphic:** Gallagher Re

# Climate Change Risk and Insurance

The economic costs of natural catastrophes continue to rise. There were 66 billion-dollar events in 2023, equivalent to one such occurrence every five or six days on average. Increased costs are driven by factors including changes in where people live; the general cost of products and labor; inflation, litigation, and the evolving behavior of weather/climate events; and broader atmospheric and oceanic patterns.

The implications of climate change, however, extend well beyond the obvious challenges associated with direct physical damage or humanitarian crises. In the longer term, it will affect the strategy and business models of governments, the financial sector, and many other players in the global economy. The insurance industry sits in a unique position to see first-hand the tough decisions that need to be made and to appropriately assess the direct and indirect risks that climate change brings.

Across the world, financial regulators are setting explicit mandates for companies to disclose how climate change risk may impact their business. For financial sector companies, these exercises can provide an important opportunity to stress-test their portfolios.

For the insurance industry, these regulatory asks come at a time when the increased cost of weather/climate claims payouts is substantially impacting underwriting performance. Accounting for climate risk in underwriting becomes more important, but also more difficult, when trying to price such risk within a 365-day window. This underscores the critical need to blend in annual natural hazard risk (including such hazard-related factors as climate change or the forecast phase of ENSO). (Re)insurers must also have robust exposure management practices.

These factors lead us to the hard question, how insurable are certain regions of the world? The answer may be that some areas require higher insurance premiums, or it may be that it is infeasible to maintain a private market presence in some areas deemed too risky to insure. This puts greater strain on government-sponsored insurance programs, which, in some cases, are holding larger percentage shares of residential lines of business. The following sections take a deeper look at the complex insurability issue in the US, how global regulators are asking for more, and what might come next.

### Insurability in the United States

The rise of insured natural catastrophe losses in the US is no longer a surprising trend for the industry. The decadal average of US insured losses has increased from USD23 billion in the 1990s to USD41 billion in the 2000s to USD75 billion in the most recent decade (2014–2023). This has been driven by consistently more expensive hurricane landfalls but also linear growth in loss costs from "non-peak" perils such as severe convective storm, wildfire, winter weather, and drought. This has led to two actions, 1) Primary insurance carriers either raising premium rates to accurately reflect the risk or pausing/ceasing to write individual lines of business in high-risk areas; 2) Reinsurers raising their rates to make it more expensive for primary carriers to purchase, reducing some coverage offerings, and reassessing portfolio exposure.

Such activity has left residents with fewer private insurance market options and has prompted an influx of new policies to state-run "insurers of last resort". These policies are typically more expensive to purchase but may often be the lone available insurance safety net for homeowners to gain access to coverage. States such as Florida, California, Louisiana, and Texas have seen some of the largest increases in policyholders on these state-run insurance programs. This leads to the question of whether the current insurance framework is sustainable in an era of higher risk and costlier claims. With states taking on more insurance policies, the federal government may eventually be required to guarantee financial protection to the states to ensure they would be able to pay insurance claims following a major catastrophe event.

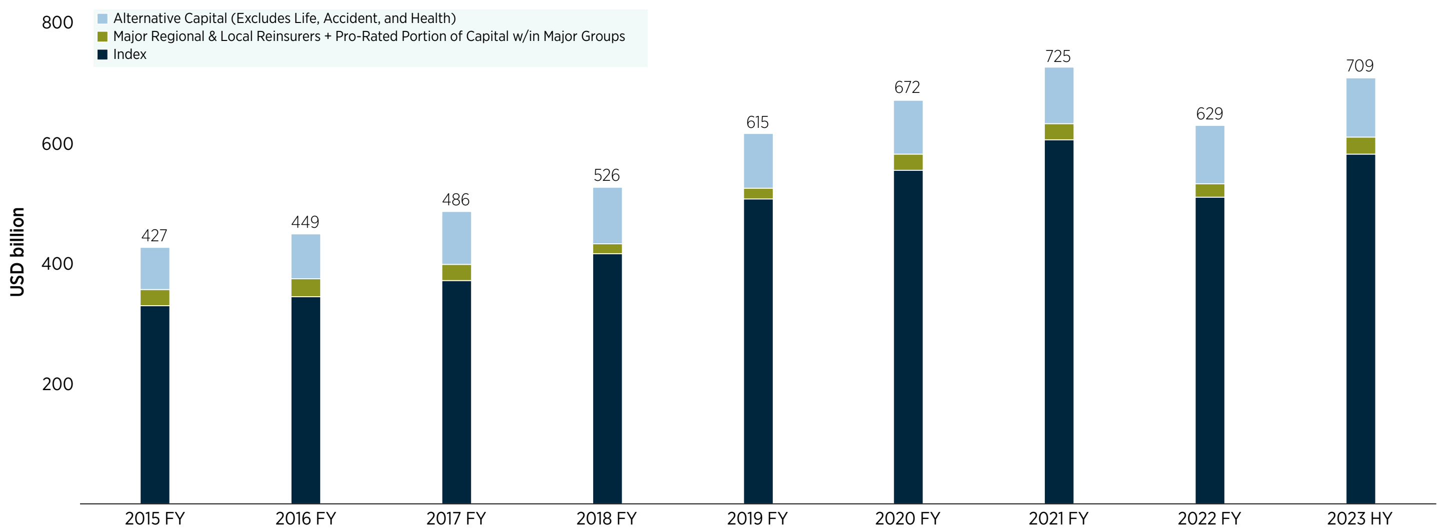



**Figure 11:** Total global reinsurance dedicated capital | **Data and Graphic:** Gallagher Re

The result of this destabilization of the US insurance market has led state regulators and governance agencies to request more data and transparency from the insurance market on how they are accounting for climate risk and where their portfolios are invested. This has come in the form of more disclosure requests from places such as the US Federal Insurance Office, the National Association of Insurance Commissioners (NAIC), and individual state insurance departments. In November 2023, the US Senate Budget Committee sent letters to 41 insurance companies requesting information on their plans to address increased underwriting losses from climate disasters and on investment decisions involving fossil fuel projects. The US Securities and Exchange Commission (SEC) is also expected to release a long-delayed series of climate-related risk disclosure rules in 2024, which will include an accounting of companies' greenhouse gas emissions (Scope 1, 2, and 3).

The US has trailed other parts of the world, notably Europe, in requiring more climate disclosures. Nevertheless, as insurability becomes a more complex issue for the private market, state, and federal officials are trying to understand the underlying issues — leading to more questions. Most focus tends to be on the insurance markets in Florida, California, and Louisiana, but the reality is that the insurability and affordability issue is a 50-state problem. Case in point — A 2023 study noted that Oklahoma had the highest average homeowner insurance premium at USD5,317 per year — or nearly double the national average of USD2,777. This was based on a policy with USD300,000 of dwelling coverage, a USD300,000 liability limit, and a USD1,000 deductible.

As homeowners seek the most affordable insurance rates, there are some strategies to consider. There are "risk-based insurance pricing" options, which can be used as a form of incentivization. Insurers may offer lower premiums to customers if they improve the structural integrity of their homes through retrofitting, for example, or use modern construction practices that meet or exceed state or local building code requirements. There are known technological and engineering improvements to limit risk to a home via higher-quality siding or roofing. The Insurance Institute for Home and Business Safety (IBHS), has available impact-resistant shingle performance ratings in the fight against hail damage. While not an explicit insurance product, there are incentivization programs now being offered by the US federal government that promote clean energy transition and improved construction practices. As an example, the 2022 Inflation Reduction Act extended the clean energy Investment Tax Credit that provides up to a 30% credit for various wind, solar, energy storage, and other renewable energy projects.

Governments, businesses, financial markets, and members of the public are seeking to better understand their own view of climate change risk. This will remain a very fluid topic in the years ahead as the regulatory environment continues to change and insurance pricing continues to fluctuate.

From an international perspective, the (re)insurability topic is also gaining steam. There has already been a notable shift in the availability (affordability) of reinsurance aggregate covers, a tightening of contractual coverage terms, and increased challenges to primary carrier earnings. To read more on recent property pricing impacts on a regional level, please view Gallagher Re's latest 1st View report.

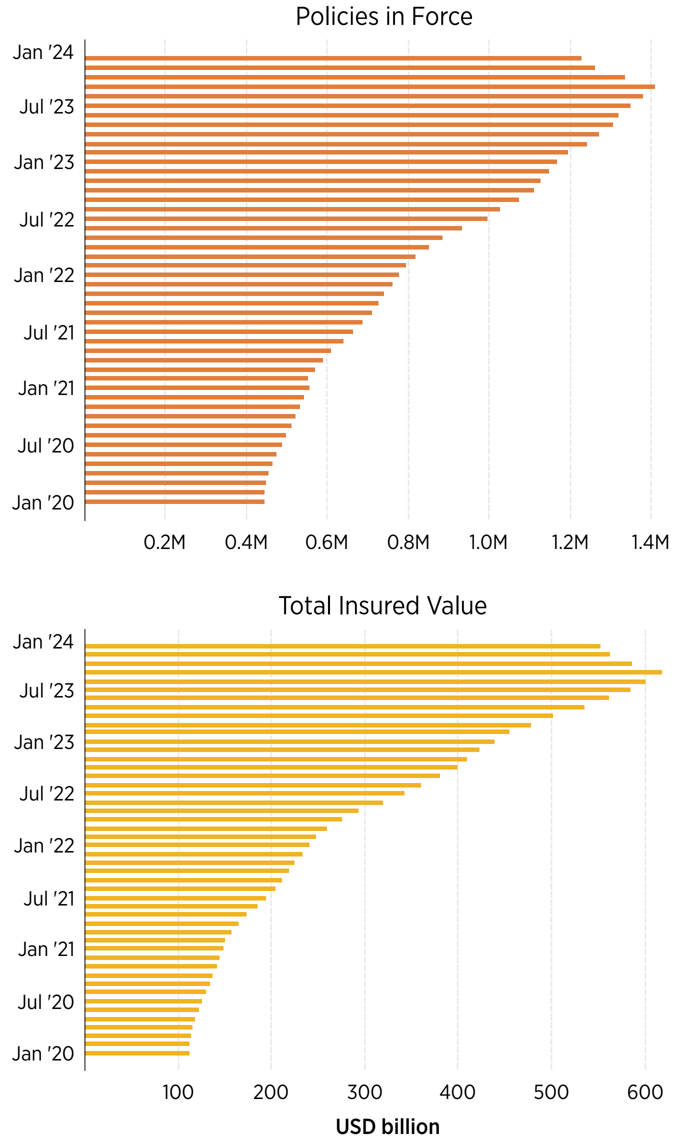



**Figure 12:** Florida Citizens Insurance statistics (2020–2023)
**Data:** Citizens Property Insurance of Florida | **Graphic:** Gallagher Re

**Florida: A stabilizing market?**

Perhaps the most explicit example of ongoing insurance challenges is in the state of Florida. Following a surge in catastrophe claims costs from a series of major hurricane landfalls, plus major issues surrounding third-party Assignment of Benefits (AOB) and corresponding claims litigation, this aided in nearly a dozen insurers that either went insolvent or reduced their product availability in the state in 2022 and 2023.

A significant series of legislative reforms were passed in an emergency state congressional session in December 2022 that sought to address many of the primary issues driving difficulties for the state's insurance market. This was additionally driven by a major influx of new policyholders shifting to Florida's insurer of last resort, Citizens.

Some components of the bill included:

- The elimination of Assignment of Benefits (AOB) practices; a process that allowed a third party to assess and file a claim with an insurance company on the insured party's behalf and then directly receive payment from the policyholder's insurer
- The elimination of "one-way attorney fees" in lawsuits from residential or commercial property claims filings
- A requirement for property insurance carriers to accelerate claims payments and claim closures
- The creation of the Florida Optional Reinsurance Assistance Program, funded with USD1 billion in state revenue to supply property insurers a chance to buy more reinsurance protection at near-market rates; and
- More requirements to qualify for a Citizens Insurance policy, including the purchase of flood insurance

As seen in Figure 12, there was a continuation of additional policies being absorbed by Citizens through most of 2023. This was partially because, in some parts of Florida, the premium for a Citizens policy was cheaper than that of a private insurer. However, a push to "depopulate" included a legislative mandate that required Citizens customers to accept private insurer coverage offers if an offer was within 20% of the cost of Citizens premiums. State approval was also granted for at least eight private insurers to take on hundreds of thousands of Citizens policies. This has since led to the first notable decline of active Citizens policies in force and corresponding total insured value (TIV). There has additionally been a reduction in litigated claims.

While the recent decline of active policies from Citizens back to the responsibility of private carriers is promising headed into 2024, the number of Citizens policyholders remains roughly three times higher than the total in 2020. Florida also escaped an expensive hurricane landfall in 2023 that would have put even more pressure on the state's insurance market. Despite this, "hard" primary market conditions are likely to persist in the near term, and not as many new carriers have entered the market as initially expected. As climate risk continues to influence hurricane behavior and the explosive growth rate of new Florida residents continues, the Florida market will remain an intense point of focus for the (re)insurance industry.

### The role of regulators

Global regulatory demands continue to grow when it comes to climate change and financial risk. As discussed earlier in this report, there are new frameworks being adopted to try to simplify/streamline various carbon accounting or disclosure standards. The importance of regulation cannot be understated in this field. At present, the voluntary carbon market is almost entirely unregulated. This means there is limited ability to prove that carbon credits are properly being used by companies or countries to offset or reduce harmful emissions into the atmosphere.

The voluntary carbon market is poised to grow exponentially over the course of this decade. The increasing number of corporations and countries setting net-zero targets is accelerating the use of credits or offsets. If some globally accepted regulatory framework is not established, it could heighten the risk of companies being correctly or incorrectly accused of "greenwashing."

### Final thoughts: What to consider next?

As we move into a riskier world with the expectation of increasing losses, there are many issues for decision-makers to consider. Perhaps nearing top of mind for private companies is the growing threat of climate litigation due to unforeseen liability concerns and/or the reputational harm that may come from being perceived as "not doing enough." With the more frequent asks by regulatory bodies, boards of directors, or activist investors, it will become imperative for companies not to fall behind.

For the (re)insurance sector, one of the top concerns is that climate change may contribute to widespread under-insurance. This could happen if more frequent disasters cause premiums (and reinsurance rates) to rise steeply, meaning less protection is bought. Even if the number of policies in force remains constant, the gap between insured and uninsured losses may still grow.

Furthermore, unforeseen broader macroeconomic events can create additional problems beyond the ever-present hazard risks enhanced by climate change. The COVID-19 pandemic, for example, had far-reaching economic effects including supply-chain disruption, lack of labor, business interruption, and other factors. These effects compounded on top of already-present climate change risks to the economy.

Finally, it is important that non-weather/climate perils are not forgotten. The earthquake peril is often an example of an "out of sight, out of mind" risk. 2024 marks the 30th anniversary of the 1994 Northridge earthquake that affected southern California. We must be mindful not to have blind spots when internally or externally assessing natural catastrophe risk, nor exclude non-climate perils in any internal stress testing or broader scenario planning within an enterprise risk management (ERM) framework.

SPECIAL SECTION

# Climate Change Liability: Amplifying Physical Climate Risk

Authors: Catherine Higham, Joana Setzer, and Tiffanie Chan

In the past decade, financial markets have seen a major shift in thinking that has led to increasing recognition that climate-related financial risks, commonly understood in terms of "physical risks" and "transition risks," must be accounted for. These two categories of risk were introduced in Mark Carney's now-famous Tragedy of the Horizon speech at Lloyd's in 2015 and popularized through the work of the Financial Stability Board's Task Force for Climate-related Financial Disclosures. They now feature in innumerable corporate and financial documents, as well as increasingly in national and subnational law and policy. But there was a third category of risk, nestled in between these two dominant risk categories, in Carney's speech that has sometimes been neglected: "liability risk." Carney warned that such risk — which he estimated might materialize "decades in the future" — would hit hard for "carbon extractors and emitters…and…their insurers." And so far, the evidence suggests he is likely to be proved right.

In recent years, the field of climate change litigation has grown significantly. There are now more than 2,300 climate cases around the world, more than two-thirds of which have been filed in the years since 2015 (Setzer and Higham, 2023), the year of both Carney's speech and the signing of the Paris Agreement, when nearly 200 countries committed to limiting global temperature increases to well below 2°C and ideally 1.5°C. (Re)insurers should not only pay attention to the growth in the number of cases but more importantly, recognize the wide diversity in the types of climate cases. This diversity manifests in multiple ways — the strategies deployed by litigants, the variety of defendants, or the remedies sought.

Two types of cases stand out as most relevant to the (re)insurance market in the short term: (i) '"polluter pays cases," also known as "climate attribution cases," in which claimants seek a contribution to the costs of adapting to or recovering from the impacts of climate change from high-emitting companies (Stuart-Smith et al., 2021); (ii) "failure to adapt cases," in which companies are sued (often by shareholders) for failing to adapt their operations to respond to the threat of climate change (UNEP 2023; Verheyen and Franke, 2023). The failure to adapt may relate to physical or financial risks associated with climate change.

**Polluter pays cases**

*Lliuya vs. RWE* is the most famous climate attribution case, in which a resident of the Peruvian Andes is suing German energy giant RWE. The claimant argues that RWE is responsible for 0.47% of historic global greenhouse gas emissions. These greenhouse gas emissions are contributing to global warming, which is in turn contributing to increased flood risk from a glacial lake near Lliuya's home. Under German property law, Lliuya argues that RWE has a responsibility to help prevent this risk to his home being realized, and they must pay for 0.47% of the costs of improving the flood defenses around Lliuya's town. Although the first-instance court initially threw out the case on the basis that it would be too challenging to prove the causal link, that was overturned on appeal, and the full trial in the case is now ongoing.

Similar cases to those filed by Lliuya have been filed elsewhere, including the case of *Asmania et al. vs. Holcim*, filed by Indonesian islanders against Swiss cement giant Holcim. There are also now more than 20 cases filed against oil majors in the US, many of which raise arguments related to the defendants' causal contributions to climate change. A number of these cases also include allegations of false advertising or climate-washing, which is one of the major issues in a much broader set of cases (Setzer and Higham, 2023). Such climate-washing cases may be brought against a corporation, but may also name directors and officers as defendants.

### Failure to adapt cases

The cases in this category cover a range of circumstances. Some cases are concerned with failures to adapt physical infrastructure to the impacts of climate change. In *Conservation Law Foundation vs. Exxon*, for example, the claimants argue that Exxon has an obligation to ensure an oil terminal and storage facility is resilient to potential climate impacts in order to protect water quality for the local community. Other cases are concerned with events that have already happened — for example, the collapse of PG&E, labeled as the world's first climate-related bankruptcy, was accompanied by a number of legal cases alleging mismanagement by both the executives and the board for failing to prevent power lines from exacerbating the risks of wildfires (Gilson and Abbott, 2020).

Another subset of failure to adapt cases concerns the failure to adapt business models to take account of transition risks such as stranded assets. These lawsuits might be filed against directors, officers, trustees, and other fiduciaries for miscommunication or mismanagement of the climate change risk of high-emission industries. One of the most discussed (though unsuccessful) cases in this category is *ClientEarth vs. Shell Board of Directors*.

To date, there have been limited numbers of both types of cases. Nonetheless, as the realities of climate change begin to hit home, it is likely that both will become more commonplace, and, as the case of *Everest Premier Insurance vs. Gulf Oil* demonstrates — when they do, insurers will find themselves very much in the middle of things. Climate change litigation presents risks and opportunities to re(insurers). Accurately priced liability insurance can play a crucial role in the low-carbon transition.

**The Grantham Research Institute on Climate Change and the Environment is a partner of the Gallagher Research Centre.**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# Scientific Discussion: Climate Change and the Role of the El Niño-Southern Oscillation (ENSO)

In 2023, we saw the return to an El Niño phase in the equatorial Pacific following a three-year period of La Niña conditions (2020–2022). During the Northern Hemisphere summer and autumn, as scientists confirmed a return to El Niño conditions, heat records were widely expected to be broken across the globe because an El Niño phase amplifies global warming by reducing the heat uptake into the ocean relative to the atmosphere.

The influence of El Niño on the 2023 weather is explored later in this report. This section identifies the role of ENSO from a climate change risk perspective. Can science predict what change might look like?

### ENSO overview

Before digging into the details, it is useful to review what ENSO is. The term El Niño refers to a state of the sea surface, and sea subsurface warming in the east of the equatorial Pacific. During neutral conditions, trade winds drive equatorial surface water towards the west. As the surface water heats on its journey westwards, the warmest equatorial Pacific Ocean sea surface temperatures (SSTs) are found in and around Indonesian waters. But during an El Niño event, equatorial trade winds are weak, thus allowing warm surface water to drift back eastwards. The eastward shift of the warmest SSTs weakens the atmospheric circulation and, therefore, trade winds. When the ocean and atmosphere circulation are locked into a feed-back loop, the equatorial Pacific is said to be in an El Niño phase.

The name El Niño stems from Peruvian fishermen observing unusually warm waters around Christmas time. The opposite phase of El Niño is referred to as La Niña. Like El Niño, La Niña is characterized by atmosphere-ocean feedback, but this time the feedback is characterized by the strengthening of trade winds, enhancing the extent of the warm waters in the west; a super-charged neutral phase. The oscillation between these three phases (El Niño, neutral, and La Niña) is referred to as the El Niño-Southern Oscillation (ENSO) and cycles on timescales of 3-7 years, with planetary-scale teleconnection patterns (i.e., linkage between weather in widely separated geographical regions).

### How ENSO affects global weather

ENSO is a fundamental driver of interannual climate variability, extending far beyond its immediate geographical footprint. ENSO occurs in a region that has the greatest net energy surplus on the planet (the equatorial region). It is a coupled ocean-atmosphere system — a system where the ocean and atmosphere are intrinsically linked. The coupling is important because oceans are the engines of weather, storing, and distributing heat across the planet dynamically via currents but also thermodynamically due to evaporation. When ENSO switches between its phases, vast amounts of energy are displaced not only geographically but also between the ocean and atmosphere. During El Niño years, when equatorial Pacific SST maxima are displaced eastward, this region experiences much greater evaporation. As moisture rises, it cools and condenses, leading to cloud formation. The enhanced evaporation (energy is used, cooling the ocean) and subsequent condensation (energy is released, warming the atmosphere) imply a heat flux from the ocean to the atmosphere. Conversely, during La Niña years, SSTs are lower, meaning less evaporation. Hence, from a global temperature perspective, La Niña years are associated with a cooling of the global atmosphere, and El Niño years are associated with a warming of the global atmosphere.

Understanding how ENSO phases enhance or suppress hazardous weather such as floods, droughts, and wildfires is of critical importance. This is a key motivator for improving ENSO predictions on multiple timescales. However, this work faces many challenges. Since the ENSO cycle is lengthy relative to the length of observational records, there are comparatively few El Niño and La Niña events that scientists have comprehensively studied. To complicate matters further, there is much variation in how these events manifest, and no single event is the same. The physical mechanisms that underpin ENSO teleconnections are numerous, and despite decades of research, there is still much to learn (e.g., Alexander et al., 2002; Bjerknes, 1969, Heureux, et al., 2024). Please see Alizadeh (2023) for a recent comprehensive review of ENSO teleconnection patterns.

### Assessing the influence of climate change on ENSO

When conducting a climate risk assessment for a multi-decadal time horizon (2030+), it is prudent to consider how good our models are at representing ENSO under climate change (known as the model's predictive "skill"). The models used for this work are generally Atmosphere-Ocean General Circulation Models (AOGCMs) or the more comprehensive Earth System Models (ESMs). For simplicity, we can refer to both as Global Climate Models (GCMs), as this is the main application of both modeling systems. These models operate in a similar way to those used for weather forecasts (they are numerical weather prediction (NWP) models). Both NWPs and GCMs simulate heat, moisture, and momentum fluxes within the Earth system (GCMs do so more extensively). However, there are also fundamental differences between the two, not only in terms of how the models are structured and their input, but also in experiment design.

Models that attempt to predict an outcome on timescales of days to weeks (e.g., NWPs) draw on signals embedded in the current atmosphere and land/ocean surface and attempt to simulate onwards the evolution of the embedded signal. Thus, a model's representation of the current (or initial) physical state is of paramount importance for its predictive skill. We expect the NWP simulations to be very close to reality, as otherwise they are of little use. By contrast, the predictive ability of GCMs does not sit so much in the initial conditions – other than planetary influences on the Earth's orbit, there is little predictability in the Earth system beyond a couple of years. Instead, GCMs respond to changing 'boundary' conditions, such as the greenhouse gas concentrations, aerosol concentrations, and land use change prescribed in the Shared Socio-Economic Pathways (SSP) (Riahi et al., 2017). In fact, it is somewhat misleading to speak about predictive skill when talking about GCMs, as they should primarily be seen as physically plausible simulations of a simplified Earth system.

Assessing the predictive skill of GCMs is difficult, as they simulate climates for future time horizons for which we have no "observational truth." It is possible to identify models that have skill in representing the current climate, but this does not automatically translate to skill in simulating climate under enhanced GHG concentrations and changing land use. Nevertheless, they are the only physically consistent tool with which scientists can explore future climate possibilities. Methods that draw on GCM data to assess future climate risk should be designed to reflect these limitations.

Acknowledging that GCMs are simplifications of the real world, they are still useful to explore the physical responses to changing boundary conditions. There are many studies that evaluate how well GCMs simulate different teleconnection patterns and potential climate change impacts, or indeed the impacts of ENSO. For example, Vaittinada Ayar, et al., (2023) compared 16 latest-generation GCMs from the 6th Climate Model Intercomparison Project (CMIP6) against observed ENSO regimes. Using real-world SST data, the authors identified five distinct regimes — two warm regimes (eastern and central pacific El Niño; EP and CP), two cold regimes (basin wide and central La Niña), and a neutral reference regime. The authors found that models were generally able to simulate the observed patterns. However, models tended to simulate overly intense and spatially extended ENSO patterns, and they had problems with capturing regime seasonality, persistence, and transition. When looking at projected change under a high-emission scenario (SSP5-8.5), the models indicated that the EP, CP, and central La Niña regimes may become more frequent, while the neutral regime becomes less common. Models further simulate an increase in variability and amplitude for the CP and central La Niña regimes.

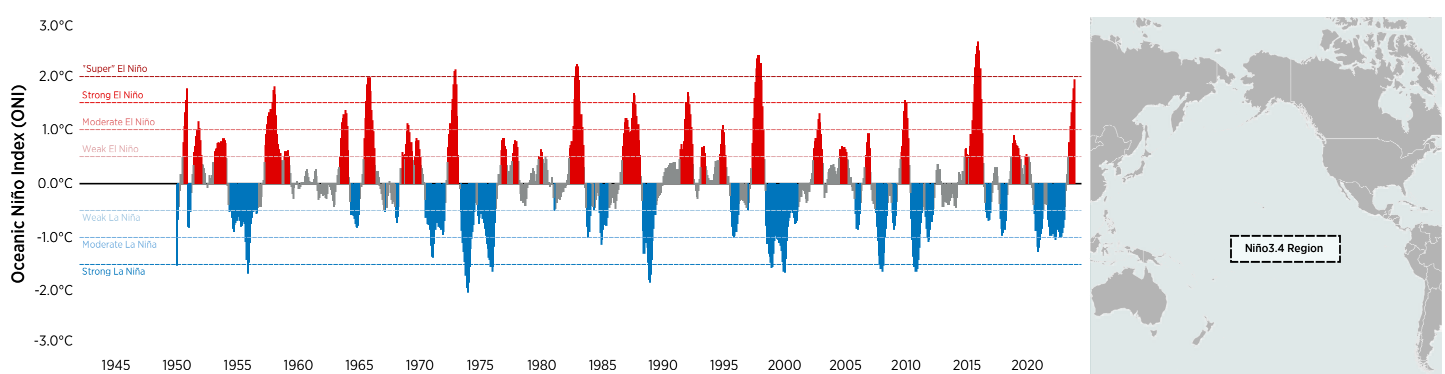


**Figure 13:** ENSO phase in the Niño3.4 region using the Oceanic Niño Index (ONI) | **Data:** NOAA | **Graphic:** Gallagher Re

Other studies focus on the teleconnection patterns associated with ENSO. For example, McGregor et al., (2022) investigated the CMIP6 models' representation of ENSO surface temperature (TAS) and precipitation (PR) teleconnection changes for several SSPs relative to the historical climate (using at least 31 different models with multiple initial condition ensemble members). Focusing on the season when the ENSO pattern typically peaks, i.e., December to February, the authors found significant TAS and PR teleconnection changes over approximately half of the teleconnected regions between a far-future time horizon (2080–2100) and the control period of 1950–2014 (the model-simulated historical period). Most results suggested an amplification of historical teleconnections, although some regions showed a significant dampening. The authors further noted that in many regions, teleconnection changes appeared to scale with the projected warming level.

When looking at projected change signals (due to changing boundary conditions), it is important to keep in mind model biases (discrepancies between simulation and reality), such as those noted by Vaittinada Ayar et al., (2023) above. Biases tend to reduce with each generation of GCM as model skills improve. For example, Hou and Tang (2022) found that the too-weak amplitude of the EP and CP regimes in 19 CMIP5 models (the previous generation of GMCs) was improved, as well as an improved spatial representation of CP in CMIP6. However, they also noted that there was no improvement in ENSO periodicity or phase-locking behavior compared to CMIP5. Looking at several metrics, the authors found only an overall slight improvement in ENSO representation in CMIP6 relative to CMIP5, which was partly due to a reduction in SST bias in the eastern part of the equatorial Pacific.

Maher et al. (2023) emphasized that future change in ENSO is uncertain because model projections differ (due to differences in model physics and structure) and because of the fundamentally large internal variability of ENSO (irrespective of climate change). Using 14 single-model initial-condition large ensembles, the authors attempted to isolate the signal in ENSO SSTs that comes specifically from climate change (as opposed to that which arises from internal or natural climate variability). Results showed non-linear changes in SSTs over time in many models, together with considerable inter-model variability in projected changes in ENSO and the mean-state tropical Pacific SST gradient. The non-linear changes in ENSO SST variability found in many models suggest that ENSO could vary dramatically throughout the 21st century.

### Final takeaways

Given the difficulties in giving robust guidance on how ENSO may change under climate change, it would be sensible for analysts in the (re)insurance sector to exercise a good amount of caution when making predictions about future changes to hazards that are strongly linked to ENSO frequency and amplitudes. There are many strategies available to analysts to support decision-making despite uncertain projection information, for example, if using GCM information, make sure you don't rely on small samples of GCMs or GCM subsets that include models with poor skill in capturing the physical and dynamical aspects of the system you are interested in. These are non-trivial tasks but will help analysts avoid potentially misleading outcomes.

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# Weather/Climate Review

# 2023: Warmest Year on Record; Supercharged by Strong El Niño and Climate Change Influence

2023 was unanimously acknowledged as the warmest year globally on record by multiple official global agencies (NOAA, NASA, Berkeley, the Met Office, and JMA). According to NOAA, the year was 1.18°C (2.12°F) above the 20th century baseline and 1.35°C (2.43°F) above the pre-industrial baseline (1850–1900). The record warmth was driven by the increasing effects of climate change alongside strengthening El Niño conditions. Global monthly temperature anomalies consistently exceeded 1°C (1.8°F) from the month of June through December (per NOAA). The year saw notable marine heatwaves and heat domes (a persistent or stuck ridge of high pressure that traps heat over a particular region for an extended period), which are becoming more prevalent and intense.

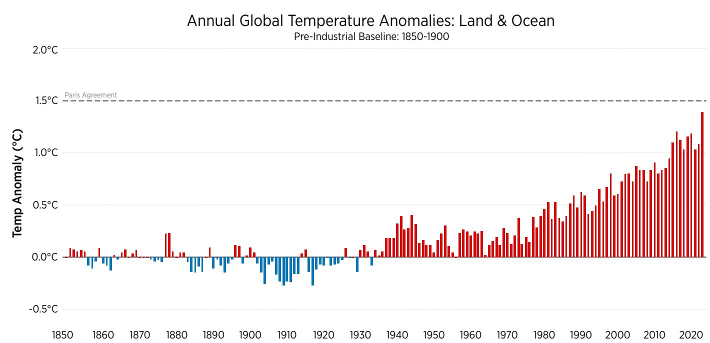
According to Copernicus, a branch of the European Union Space Program, global temperature anomalies crossed the 1.5°C (2.7°F) threshold for six consecutive months (July to December) when compared against the pre-industrial baseline. This threshold is an important climate benchmark as established by the Paris Agreement and puts the world on a path towards tipping points that would bring even more significant climate effects. However, scientists confirm that while even a single year surpassing the threshold is noteworthy, it will be of much greater concern when the threshold is regularly exceeded. Such global heat extremes are worrying, as they are likely to spur further melting of ice sheets, increase the intensity of tropical cyclones, and make local heatwaves more frequent and severe — confirming the projections of climate change research.

| Rank | Year | 20th Century Baseline | Pre-Industrial Baseline |
|---|---|---|---|
| 1 | 2023 | 1.18°C / 2.12°F | 1.35°C / 2.43°F |
| 2 | 2016 | 1.03°C / 1.86°F | 1.20°C / 2.16°F |
| 3 | 2020 | 1.01°C / 1.82°F | 1.18°C / 2.12°F |
| 4 | 2019 | 0.98°C / 1.76°F | 1.15°C / 2.07°F |
| 5 | 2017 | 0.95°C / 1.71°F | 1.12°C / 2.01°F |
| 6 | 2015 | 0.92°C / 1.65°F | 1.08°C / 1.95°F |
| 7 | 2022 | 0.91°C / 1.63°F | 1.08°C / 1.94°F |
| T-8 | 2018 | 0.86°C / 1.55°F | 1.03°C / 1.85°F |
| T-8 | 2021 | 0.86°C / 1.55°F | 1.03°C / 1.85°F |
| 10 | 2014 | 0.77°C / 1.38°F | 0.93°C / 1.68°F |

**Table 3:** Top 10 warmest years on record dating to 1850 | **Data:** NOAA

Monthly average global temperatures were broken consecutively during the boreal (Northern Hemisphere) late spring and summer months. Daily temperature anomalies relative to the 1991–2020 baseline continued an increasing trend as El Niño further established itself in the second half of the year. Nearly every day after May 1 saw daily anomalies that were higher than any day recorded since 1958. Figure 14 showcases annual land and ocean temperature anomalies from 1850–2023 compared to the pre-industrial baseline (1850–1900) and daily average global temperatures from 1958–2023. Both show continued global warming.

Please note that the major official global agencies do have differing pre-industrial baseline averages. For example, Berkeley Earth's annual mean is 0.13°C (0.23°F) warmer than NOAA's pre-industrial baseline. This means that some agencies may show that 2023 surpassed the 1.5°C Paris Agreement threshold, while others may have been just below.



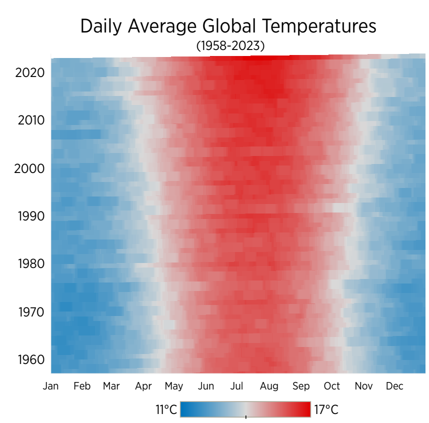




**Figure 14:** Annual global land & ocean temperature anomalies vs the pre-industrial baseline (top) and daily global temperature average vs 1991–2020 climatology (bottom)
**Data:** NOAA & Japan Meteorological Agency (JRA-55) | **Graphic:** Gallagher Re

### Temperature and precipitation anomalies over land

Global temperature anomalies in 2023 were unprecedented and record-setting. Every month from June through December broke monthly global warmth records. The year concluded with temperatures running well above the most recent 1991–2020 climatological baseline. The Arctic, northern Canada, and central Asia exhibited some of the strongest warming signals. Higher than normal temperatures in Canada aided in record wildfire activity. Both South America and Africa saw their warmest June to August and September to November periods on record, which further amplified regional drought conditions and later exacerbated flooding events. Several areas that experienced excessive rainfall, such as the Horn of Africa, ended up with near- to slightly above-normal temperatures. Overall, every continent on the globe saw above-average temperatures in 2023.

These increasingly warm land temperatures are having notable consequences. They are particularly detrimental to glaciers. There were numerous examples of the rapid melting of an overland glacier leading to a glacial lake outburst flood (GLOF). For example, the Swiss Commission for Cryosphere Observation has observed catastrophic losses of ice sheets in recent years. Glaciers in Switzerland contracted 10% in volume between 2022 and 2023, the same amount of ice lost between 1960 to 1990. Increased atmospheric heat also means that ice will only freeze at higher elevations.

Annual mean temperatures are significantly modulated by the rhythm of ocean-atmosphere interactions and tend to be warmer during El Niño years and the year following it. Given this, it is likely that 2024 will continue to see countries reporting new daily and/or monthly temperature records. Whether 2024 sets a new global temperature warmth record remains to be seen, but it is entirely plausible for it to again end as one of the Top 10 warmest years dating to at least 1850. Global average temperature for the 12-month period ending in January or February this year looks set to exceed the 1.5°C pre-industrial threshold for the first time in history.

Please view Figure 15 for a closer look at which parts of the world recorded temperature abnormalities in 2023. The darker red colors indicate warmer than normal, and shades of blue showcase cooler than normal. As previously discussed, most of the world was well above normal.

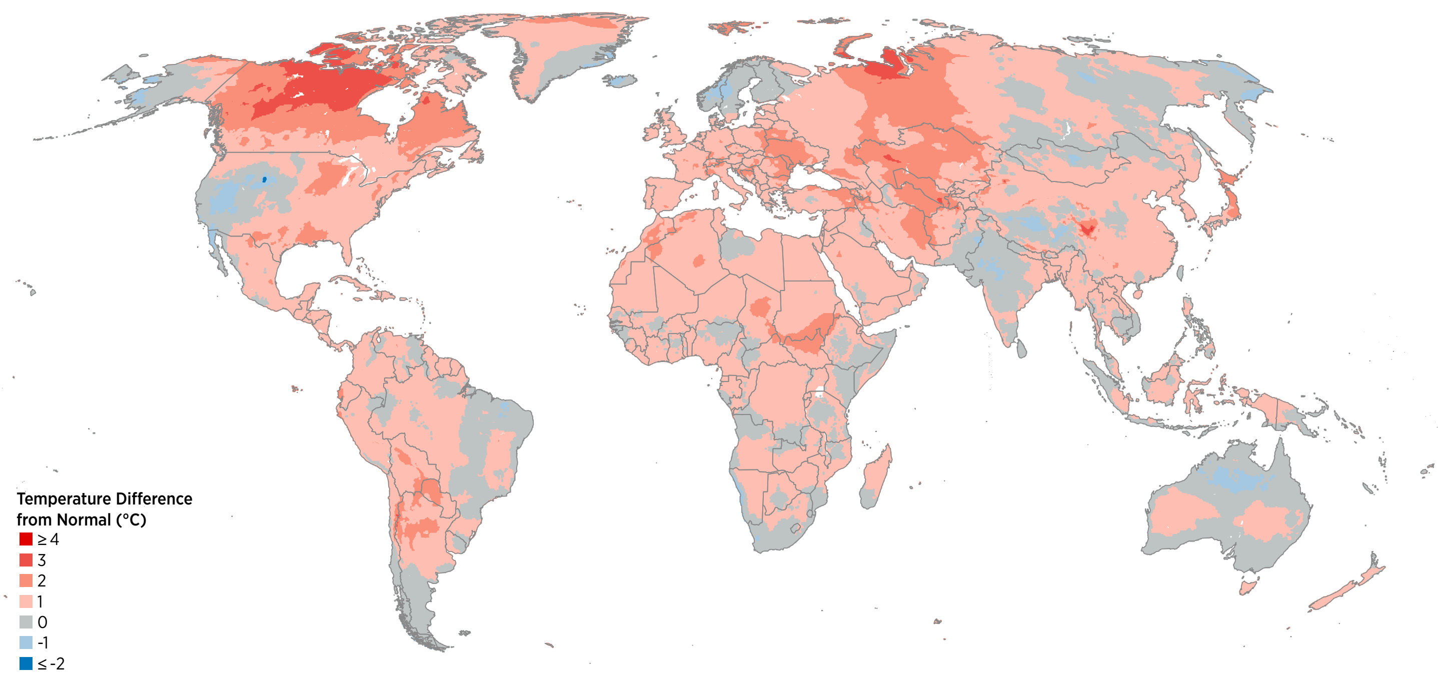



**Figure 15:** 2023 global temperature anomalies compared to the 1991–2020 climatological normal | **Data:** Copernicus (ERA5) | **Graphic:** Gallagher Re

Rainfall patterns throughout the year varied across the continents. Some of the most extreme precipitation totals (minimum or maximum) were influenced by climate oscillations, blocked/stuck weather patterns, and an enhancement from tropical moisture. Above-average rainfall in the US Southwest was driven by a series of impactful atmospheric river events in Q1, which also aided in a relatively quiet wildfire season. Following severe drought conditions, persistent rainfall in Q4 resulted in anomalously wet conditions in the Horn of Africa. Continued drier than average weather in northern Africa and much of central South America enhanced drought and further stressed regional agriculture and transportation.

Precipitation anomalies (where an anomaly is defined as the difference from normal) were largely at or above normal across most of Europe (see Figure 16). The lone exceptions were seen in southern Spain and Portugal, which were notably below normal for the year. Ireland had its wettest July on record, while a series of windstorms had the Netherlands recording its wettest November. Denmark reported its wettest year on record since at least 1999. SCS events in Italy and Storm Daniel's impact on Greece and Libya likewise contributed to above-normal rainfall in parts of these countries.

Much of central and south-eastern Asia experienced dry conditions. Historic rainfall in northwest India, the passage of Cyclone Michuang along the coasts of Tamil Nadu and Andhra Pradesh, and the "plum rain" season in central South Korea led to wet anomalies in these areas. Australia was largely, dry as it recorded its two driest months from September to October. This was largely driven by a rapid shift to a positive phase of the Indian Ocean Dipole (IOD). A wet November eased rainfall deficiencies in the east. It was anomalously wet in north Queensland, in part due to Cyclone Jasper in December.

Please view Figure 16 for a closer look at which parts of the world recorded precipitation abnormalities in 2023. The darker green colors indicate higher than normal precipitation, and shades of brown showcase less than normal precipitation.

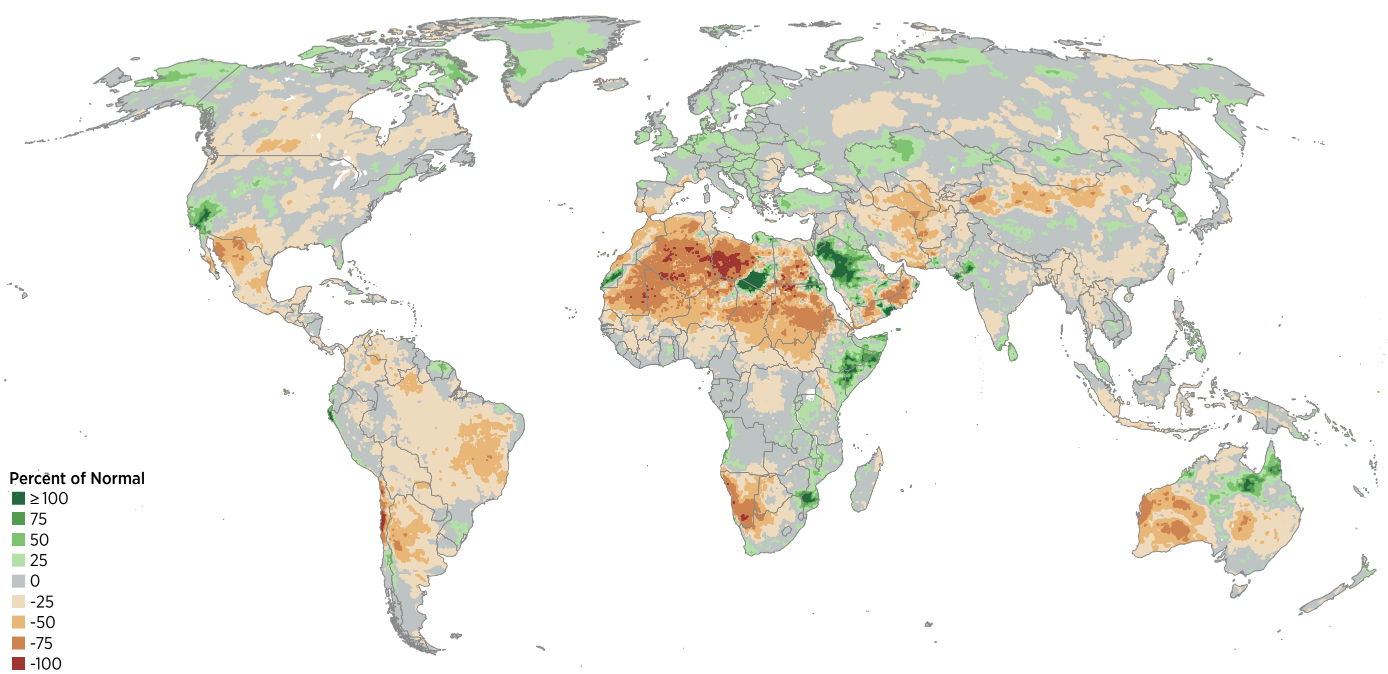



**Figure 16:** 2023 global precipitation anomalies compared to the 1991–2020 climatological normal | **Data:** Copernicus (ERA5) | **Graphic:** Gallagher Re

SPECIAL SECTION

# Making the Smart Transition in Your ESG Strategy

Author: James Bosley

After two weeks of talks in Dubai, the COP28 climate summit concluded with a historic deal calling for a "transition away" from fossil fuels exactly 24 hours after the official end of the summit. The summit saw a fierce battle between countries that wanted language to include the "phase out" of fossil fuels, and those against it, who wanted to prioritize other methods of reducing emissions such as carbon capture.

Whilst both topics were hotly contested, there was consensus concerning the importance of renewable energy sources and evidence in abundance that the energy transition is well underway. COP28 was awash with solar, wind, nuclear, and hydrogen solutions, ranging from large hybrid energy corporations with a global presence to technology start-ups and consulting firms.

Insurance already plays an important role in the renewables sector, providing coverage from project inception, through construction and subsequent operations. This includes guaranteeing technology performance, as well as covering construction delays; subsequent operational risks; the threat of political instability and violence; and credit risk.

Nevertheless, where insurance will be essential is in facilitating the de-risking of the transition and enabling the scale, resilience, and bankability of potential solutions.

The climate transition, however, is not limited to the energy transition but presents new risks across a company's full value chain. The impact will be felt to some degree across most, if not all, client sectors. Climate change has led to the increasing frequency and severity of natural catastrophes impacting either directly on a company's physical premises, or indirectly through non-damage business interruption of their operations or supply chains.

Without adequate insurance to respond to transition needs or the increasing risks of climate change, the ambitious commitments made at COP28 will struggle to come to fruition and companies may find themselves increasingly exposed to balance sheet risk.

Gallagher Specialty is focused on enabling our clients by identifying these transition-related risks and addressing the genuine client need for new solutions. This includes not only enhanced insurance coverages, but the creation of specific risk transfer mechanisms for increased natural catastrophe exposures as well as advisory services to support our clients' ongoing resilience and adaptation journeys.

**James Bosley is the head of climate strategy at Gallagher Specialty.**

# El Niño and its Influence on Tropical Cyclone Activity

The 2023 tropical cyclone season was anomalous against the backdrop of a moderate El Niño event. Tropical cyclone activity in the North Atlantic was above average while typhoon activity in the Western North Pacific was considerably below average. In typical El Niño years, the statistics are reversed.

### North Atlantic

Despite El Niño conditions, favorable atmospheric circulations and unprecedented oceanic heat content in the Gulf of Mexico and Caribbean Sea, enhanced by a warming climate, aided in an active North Atlantic hurricane season. 2023 saw 20 named storms, which was above the average of 14. It was also the fourth highest total of seasonal named storms since 1851, and of note, the only other three years to have at least 20 named storms have occurred since the start of the 21st century: 2020 (30), 2005 (28), 2021 (21). Seven of the 20 named storms intensified into hurricanes, and three reached major hurricane status (Category 3+).

According to NOAA, more named storms formed in the Atlantic basin this year than in any other El Niño year on record. El Niño years are historically less active in the Atlantic due to an increase in wind shear which tends to inhibit storm strengthening and formation. Concurrently, a weaker and less expansive Bermuda High during positive ENSO events often causes storms to recurve away from the US and remain in the open waters of the Atlantic.

Even with an active season, the annual financial toll in the Atlantic was relatively low compared to recent seasons despite two hurricanes (Idalia and Tammy) and three tropical storms (Harold, Franklin, and Ophelia) making landfall across the basin. Lee came ashore in Nova Scotia, Canada as a post-tropical cyclone. The most impactful, Idalia, resulted in industry losses of USD1.25 billion. This was less than initially feared due to the storm's landfall in Florida's sparsely populated Big Bend region. Overall, insured losses in the Atlantic basin reached USD1.5 billion, the lowest such total since 2015.

### Eastern Pacific

The Eastern Pacific similarly saw an above-average season featuring 17 named storms and 10 hurricanes, of which eight obtained major hurricane status (Category 3+) — compared to the current climatological mean (1991–2020) of five major hurricanes a year. After a slow start, with no named storms forming until late June, anomalously warm sea surface temperatures in the tropical Pacific (directly correlated to the ongoing El Niño episode) aided in fueling an increase in tropical cyclone activity for the remainder of the season.

Most notable were hurricanes Lidia and Otis which underwent rapid intensification prior to landfall on Mexico's Pacific coast, a scenario which becomes more likely amid continued atmospheric warming. Hurricane Otis' Category 5 landfall near Acapulco ranked as the strongest Pacific landfalling hurricane and the costliest event in Mexico's recorded history. Both Jova and Otis obtained Category 5 status, the first Category 5 hurricanes in the basin since 2018.

One of the most unusual events was Hurricane Hilary, which made landfall during August in Mexico's Baja California before weakening and later entering the US Southwest. This was the first tropical system to impact the US state of California since 1997.

| Basin | Named Storms | Hurricanes | Major Hurricanes | Accumulated Cyclone Energy |
|---|---|---|---|---|
| North Atlantic | 20 (14.3) | 7 (7.2) | 3 (3.2) | 145.6 (122.5) |
| Eastern North Pacific | 17 (16.6) | 10 (8.8) | 8 (4.6) | 164.0 (132.8) |
| Western North Pacific | 16 (25.3) | 11 (15.9) | 8 (9.2) | 271.7 (299.0) |
| North Indian | 8 (5.3) | 4 (2.1) | 3 (1.0) | 57.5 (24.0) |
| **Northern Hemisphere** | **61 (61.5)** | **32 (34.0)** | **22 (18.0)** | **638.8 (578.2)** |
| South Indian | 8 (16.3) | 6 (9.0) | 4 (5.1) | 149.2 (136.8) |
| South Pacific | 9 (9.5) | 6 (4.6) | 4 (2.5) | 69.9 (69.9) |
| **Southern Hemisphere** | **17 (25.8)** | **12 (13.6)** | **8 (7.6)** | **219.1 (206.7)** |
| **Global** | **78 (87.3)** | **44 (47.6)** | **30 (25.6)** | **857.9 (788.8)** |

**Table 4:** 2023 calendar tropical cyclone statistics by basin compared to 1991–2020 climatology | **Source:** JTWC / NOAA

### Western North Pacific

The Western North Pacific, on the contrary, was relatively quiet in typhoon activity. There were 17 storms this season, of which 16 formed within the basin. One storm, Dora, originally developed in the Eastern Pacific and crossed the dateline into the Western Pacific. Based on current climatology (1991–2020 average) 25 storms form in the Western North Pacific a year. This was the fourth consecutive year for below-average typhoon formation, and the first year since 2010/2011 with fewer than 20 tropical storms. The anomalous inactivity was unexpected given that sea surface temperatures were sufficiently warm and there was a weakening of the Walker Circulation (i.e., a weakening or reversal of trade winds) during El Niño. A combination of a strong seasonal subtropical high, a weak equatorial monsoon trough, and a suppressed phase of the Madden-Julien Oscillation (MJO) during the autumn months were likely contributors to reduced storm activity during the second half of the 2023 season. Middle tropospheric moisture and vertical wind shear were possible minor factors as well. See Figure 17 for an example of autumnal seasonal conditions in place.

During a "typical" El Niño phase, there is an eastward shift in where storms originally develop (storm formation is known as "cyclogenesis"). This increases the time and distance which typhoons track over water. Such a set-up usually leads to increased numbers of storms and a higher potential for landfall in East Asia.

### South Pacific

The South Pacific had an above average season with three named storms since October. According to Australia's Bureau of Meteorology (BoM), during El Niño, there are fewer tropical cyclones in the western South Pacific (about 165°E), and near normal to above average tropical cyclones in the eastern South Pacific. The Regional Specialized Meteorological Center in Fiji, however, forecasts an elevated risk of tropical cyclone activities during the 2024 calendar year.

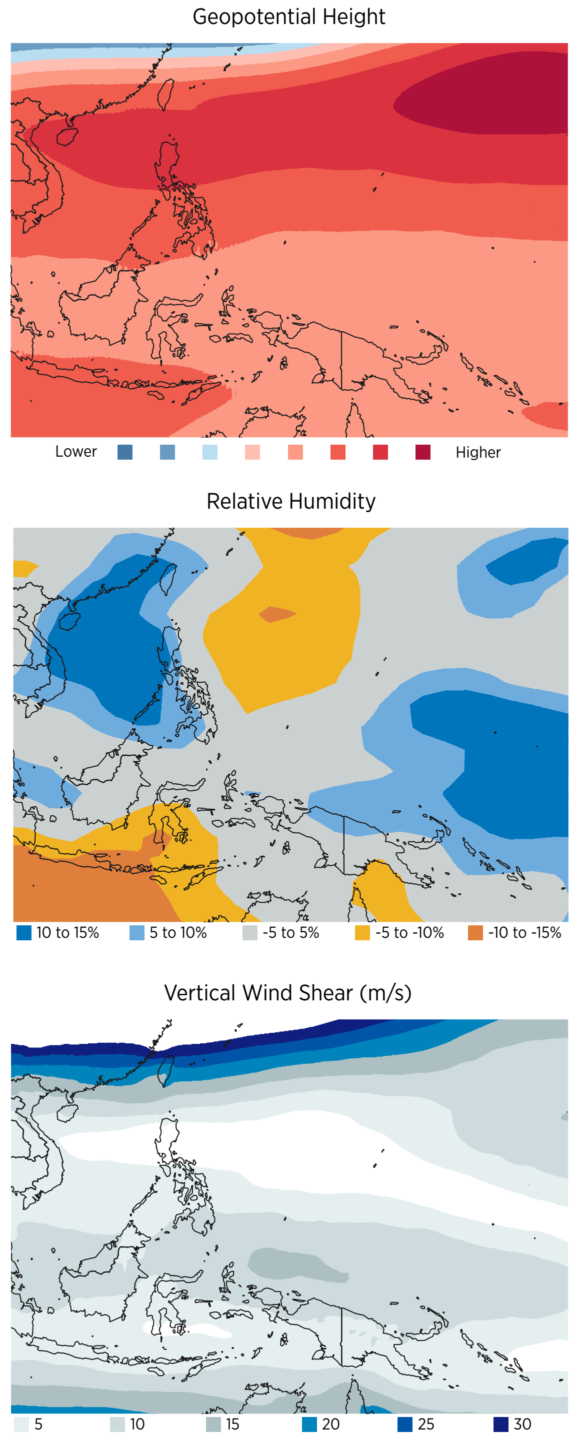



**Figure 17:** During the autumnal months the Western North Pacific featured conditions that were not entirely conducive for cyclogenesis, including a strong ridge of high pressure (top), fairly neutral atmospheric moisture content (middle), and somewhat higher vertical wind shear (bottom)
**Data:** Copernicus (ERA5) / JMA / BoM | **Graphic:** Gallagher Re

**ENSO Forecast: 2024 Tropical Cyclone Season**

As seen in Figure 15, the ENSO forecast models suggest a steady weakening of the current El Niño towards ENSO-neutral conditions by the boreal spring months in 2024. Longer-range guidance also suggests a full shift back to La Niña in the second half of 2024. It is worth noting that following historical events in which El Niño peaks in the boreal autumn months (September to November), the pendulum has shown a tendency to quickly swing back to La Niña conditions the following year. This has been the case in five of the six historical analogs of strong El Niño phases since 1950 (see Figure 18). While uncertainty exists and no single event is the same, this signals that La Niña may again develop during the peak 2024 Atlantic hurricane season. The positive feedback loop of El Niño on global temperature typically manifests a full year after its development, and 2024 may potentially be another Top 5 year in the modern era for anomalous temperature warmth on land and in the oceans.

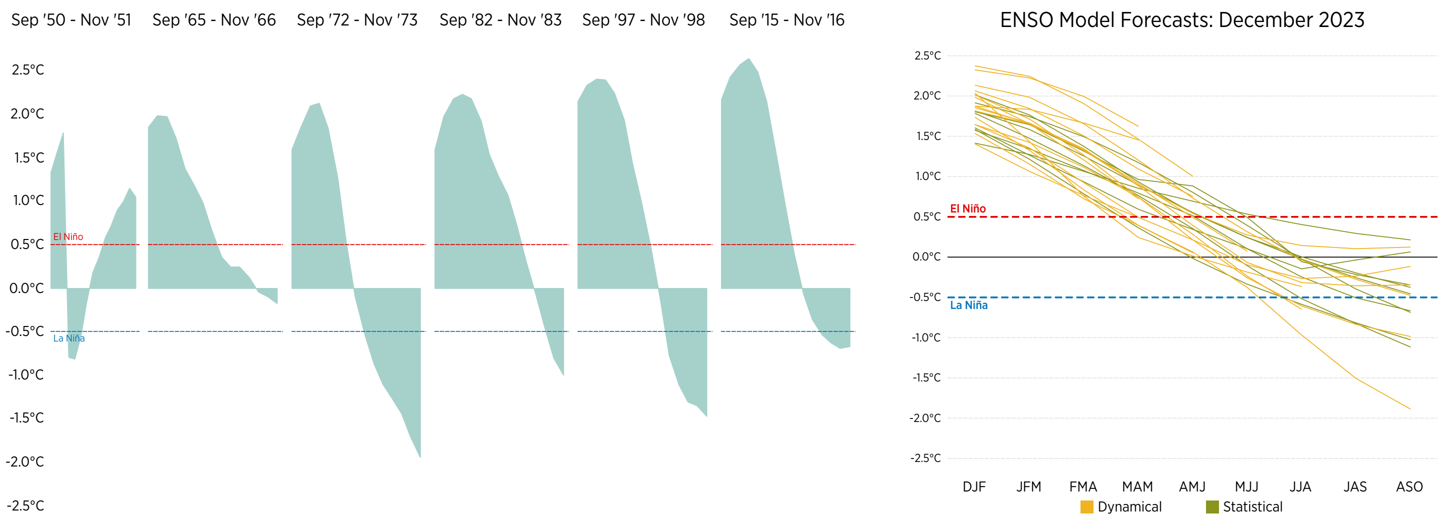



**Figure 18:** Last 5 strong boreal autumn El Niño phases + 15 months after (left) and 2024 ENSO forecast guidance (right) | **Data:** NOAA IRI | **Graphic:** Gallagher Re

# Antarctic and Arctic Sea Ice Extent

The record global warmth was most prominently felt in the north and south poles. It was especially notable in the Antarctic, where sea ice extent was at a record daily minimum for 197 consecutive days from April 27 to November 9. It reached an annual minimum extent of 1.79 million $km^2$ (691,000 $mi^2$) on February 20, and an annual maximum extent of 16.96 million $km^2$ (6.55 million $mi^2$) on September 10 — both were the lowest in the 45-year modern satellite era dating back to 1979. The 2023 maximum extent was also observed at one of the earliest dates on record, occurring 13 days before the 1981–2010 mean maximum extent date, and the difference in land area against the previous maximum record were more than the size of France and Germany combined.

In late November, the world's largest iceberg, known as "A-23", drifted away from the Antarctic into the southern Pacific Ocean. Measuring 40 by 32 nautical miles (74 by 59 km), the iceberg was roughly three times the size of New York City. The World Meteorological Organization (WMO) indicated that the Antarctic experienced a 75% increase in ice loss between 2011–2020 compared to 2001–2010. This accelerated trend of ice sheet mass loss is projected to continue for the 2021–2030 decade alongside accelerated warming in the world's oceans.

In the Arctic, the 2023 sea ice minimum annual extent ranked as the 6th lowest on record and occurred in late September. Since that time, the Arctic sea ice growth period accelerated at a slightly faster than average pace through the end of the calendar year. A pause in ice growth occurred in late November, as warm moist air was transported northward. While unusual, similar pauses have been observed in the past, such as in 2013 and 2016.

In addition to extent, data regarding the age and depth of sea ice is a critical component, particularly in the Arctic, as younger and thinner ice enables more heat to escape into the atmosphere.

The Antarctic and Arctic ice sheet and sea ice coverage in the surrounding ocean are essential to the broader regulation of Earth's climate. The bright ice reflects energy from the sun back into the atmosphere, while the darker ocean surface absorbs most incoming energy and reinforces increases in temperature. Decreasing sea ice and amplified polar warming could lead to greater coastal exposure and erosion.

The concern for the insurance industry and other financial sectors is the growth in coastal risk from sea level rise and other water-related impacts. Higher seas could bring potential increased premium costs or the prospect of reduced property values. It will also lead to higher storm surge during tropical cyclones which may bring water further inland than previously seen.

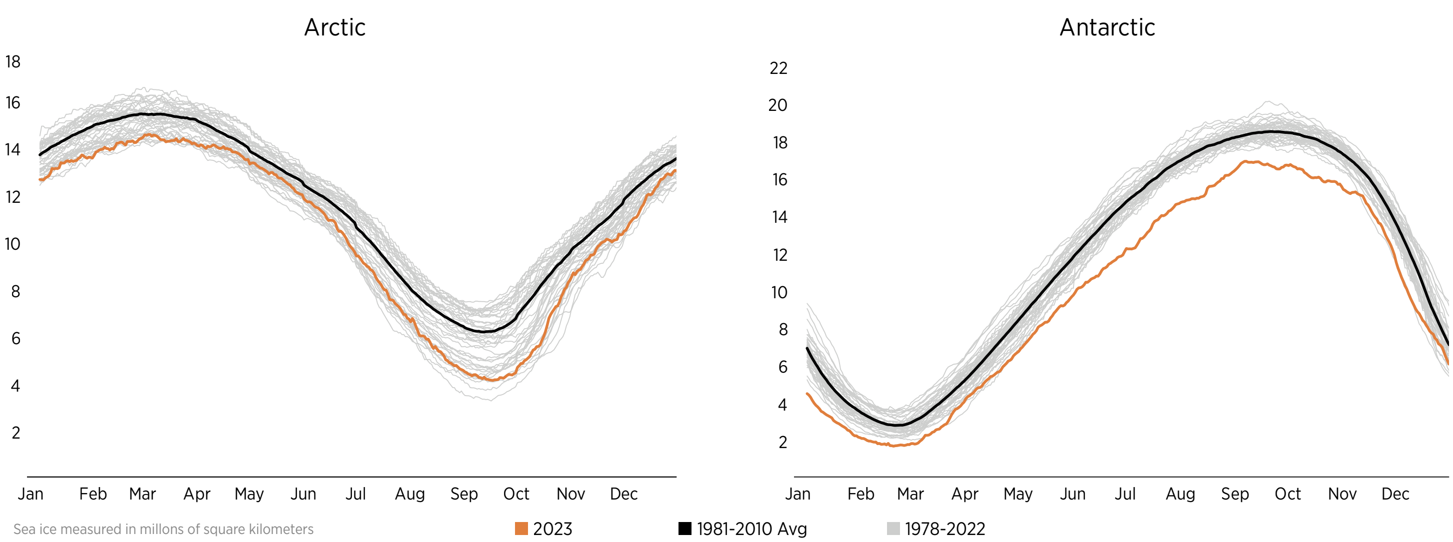



**Figure 19:** Sea ice extents (millions of square kilometers) in the Arctic and Antarctic (1978–2023) | **Data:** NSIDC | **Graphic:** Gallagher Re

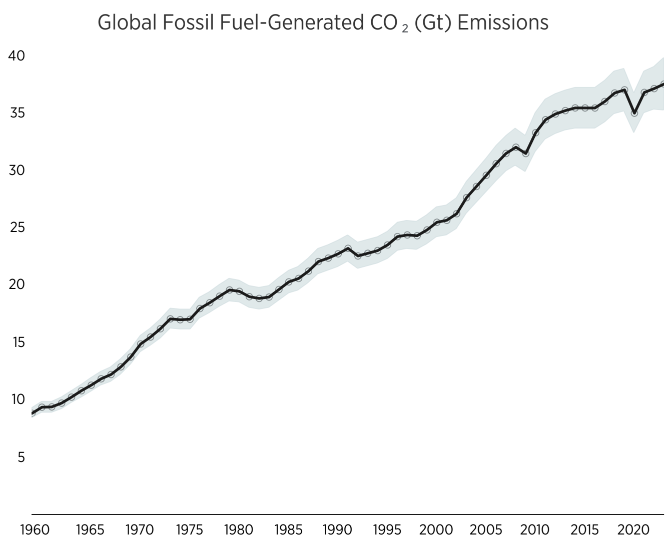
### Global Greenhouse Gas Emissions

As new warm global temperature records were established, 2023 saw the continued rise in global carbon dioxide ($CO_2$) emissions. Per the Global Carbon Budget project, fossil fuel emitting carbon dioxide emissions neared 36.8 gigatons (Gt) in 2023. This represents an increase of approximately 1.1% from 2022 levels (37.1 Gt) and nearly 1.4% above the pre-COVID-19 levels.

While the rate of growth in $CO_2$ emissions has slowed in recent years as the effect of further investment into green energy technologies and environmentally friendly federal policies take hold, the overall emissions total did trend higher globally. This was influenced by regional increases, such as those observed across China and India in 2023. Concurrently, several regions, including the US and Europe, have shown short-term steady or declining emission trends. Further and quicker action leading to decarbonized economies would be required to mitigate worsening economic and humanitarian impacts from a warming climate and are necessary to keep the global average temperature below the target of 1.5°C above pre-industrial levels, set in the Paris Agreement.

Global carbon dioxide concentration measurements are conducted at Mauna Loa Observatory in Hawaii due to limited influence from direct pollution. Data at the Observatory reliably dates back through 1958. For 2023, the Mauna Loa Observatory recorded a new record weekly high of 424.6 ppm the week beginning May 28 and a record daily high of 424.9 ppm measured in early June. Concurrently, the monthly average $CO_2$ concentration in 2023 remained at or above 418 ppm throughout the year. While total atmospheric $CO_2$ has continued to grow on an annual basis, $CO_2$ concentrations in the Northern Hemisphere simultaneously follow a seasonal cycle which peaks in the spring and declines throughout the late summer (as plants require $CO_2$ for growth).

Atmospheric carbon dioxide levels have a proven correlation with global temperatures, owing to the greenhouse effect. Greenhouse gases, such as $CO_2$, absorb heat radiating from the planet's surface and redistribute it in all directions (including back toward the surface). Once emitted, atmospheric $CO_2$ does not readily dissipate. This results in a notable lag between emission reductions and atmospheric concentrations.



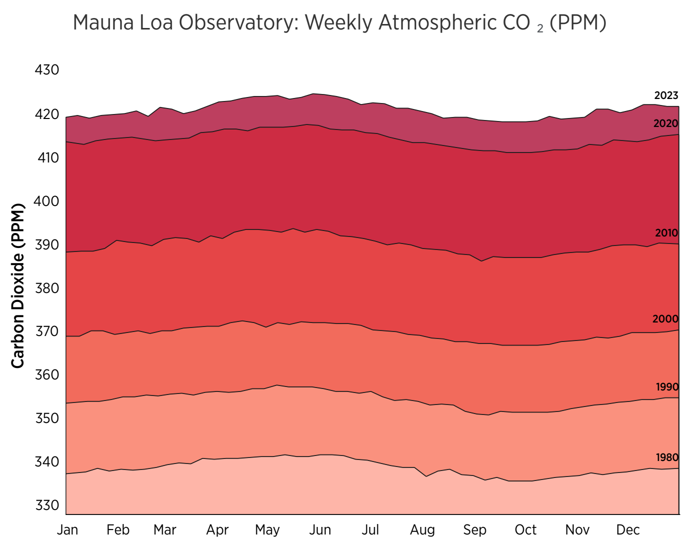




**Figure 20:** Global fossil $CO_2$ emissions (Gt) and weekly atmospheric $CO_2$ monitored at Moana Loa | **Data:** Global Carbon Budget and NOAA | **Graphic:** Gallagher Re

SPECIAL SECTION

# The Era of Record SCS Losses: The Broker Perspective

Authors: Alexandra Glickman, Martha Bane, and Robby Kunz

2023 marks the costliest year ever recorded for severe convective storms (SCS). With insured losses of nearly USD60 billion alone recorded in the United States, there is increased focus on how primary insurance carriers and their policyholders should consider the peril. The following provides some guidance from Gallagher retail experts on how this increased SCS risk should be viewed.

### What does this mean for insureds?

If losses of this magnitude persist, insureds must consider risk mitigation strategies, the quality of their submissions to insurers, and the terms and conditions associated with coverage.

### Risk mitigation strategies

Today's economic climate of elevated interest rates has made projects or asset acquisitions that require debt financing less attractive. Insureds with cash on hand should focus on applying planned CapEx to hardening their assets — for example, fortifying buildings.

During a severe convective storm, strong winds and sometimes hail wreak the most havoc on a structure's exterior, particularly the roof. When repairing or hardening roofs, consider lessons learned from hurricane-exposed states like Florida. Metal roofing materials can withstand Category 4 hurricane-force winds of up to 160 mph or the equivalent of an EF3 tornado (136–165 mph). Conversely, brand-new asphalt shingles and similar roofing types can only withstand Category 2 hurricane-force winds of 110 mph, or the equivalent of an EF1 tornado. This number drops as low as 50 mph for older asphalt shingle roofs or an EF0 tornado (65–85 mph).

Less costly strategies like trimming trees and securing objects that may become projectiles can also help to minimize damage. Additionally, taking care to preserve the property from further damage in the wake of a loss is just as crucial as pre-loss mitigation. Systems of rain often accompany these SCS. If at all safe to do so, closing holes with temporary roofing can mitigate further water damage.

### Submission data quality

As predictive models catch up to perils like SCS, underwriters have more manual work to do when determining property exposure to loss, and they will err on the side of caution. Make sure you tell your story and give a data-defensible picture of your risk, rather than falling victim to underwriter assumptions. More data leads to better underwriting and more efficient pricing. For example, go beyond roof age, and include construction type, material, and architectural style. These are important characteristics that help an underwriter determine their loss exposure.

### Terms and conditions associated with coverage

By now, most insureds are accustomed to percentage wind hail deductibles which are relatively new in the Midwest region of the United States. Where coastal geographies exposed to Tier 1 wind risk have seen as high as 10% and 15% during these hardened market conditions, insureds in the central US are just getting used to 1% and 2%. Expect insurers to push for increases in these deductibles, especially on loss-affected business.

Lastly, insureds should review their Ordinance and Law limits with their broker. Florida has some of the most progressive building codes in the country for dealing with wind. They have proven their worth when evaluating the loss performance of newly constructed buildings against older buildings. As SCS losses persist, building codes must adjust to accommodate. Ensuring adequate O&L limits will ensure that at the time of loss, older properties are prepared to comply with the new regulations.

**Alexandra, Martha, and Robby are colleagues in Gallagher Global Brokerage.**

# Regional Recaps

# United States (US)

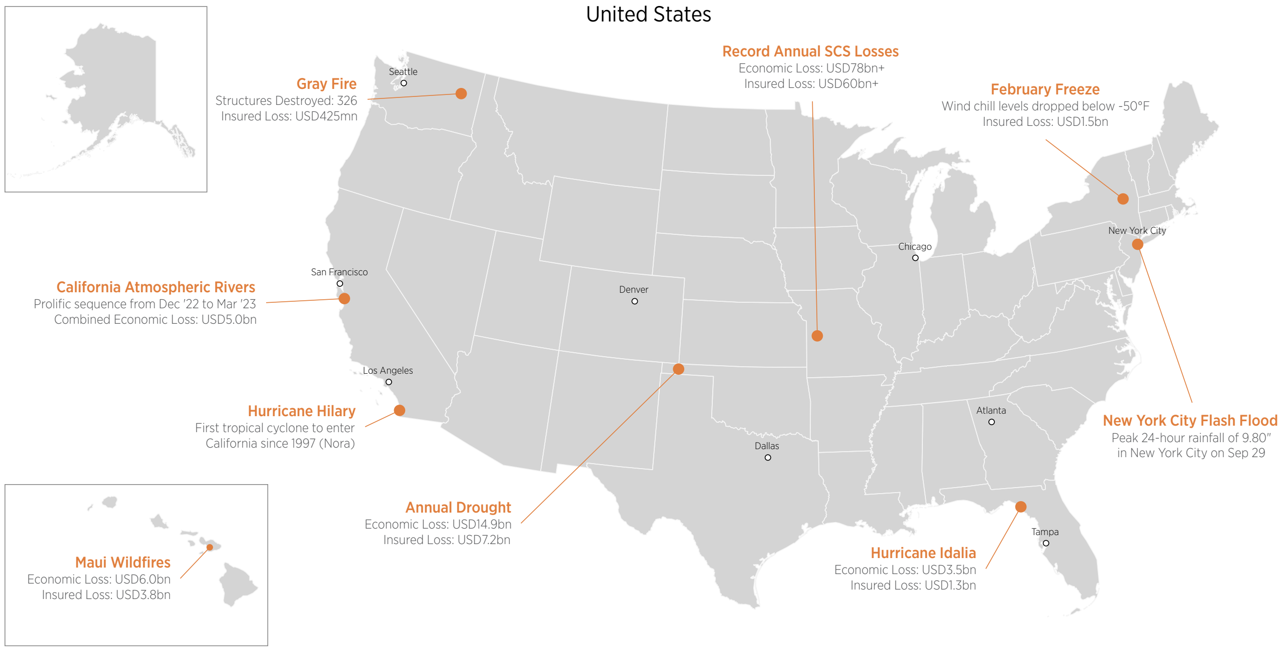
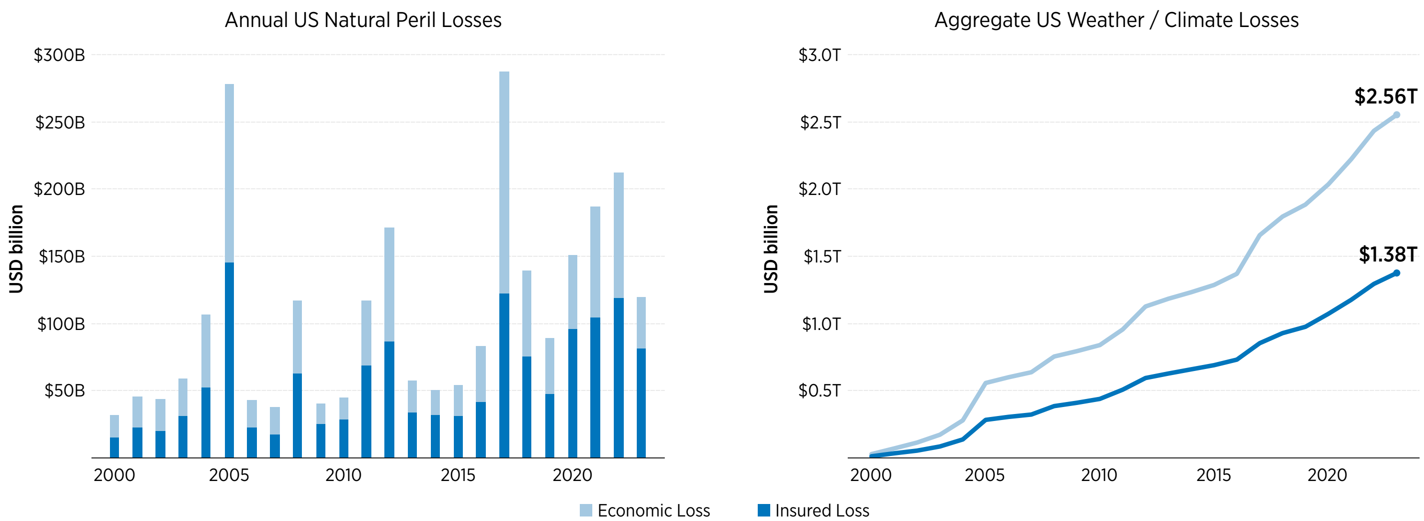



**Figure 21:** Map of notable United States events in 2023 | **Data and Graphic:** Gallagher Re




Notable Statistics in 2023

**20**
US SCS Billion-Dollar Insured Loss Events

**25.91"**
Peak 24-Hour Rainfall in Fort Lauderdale, FL on April 12

**8**
Number of Cat. 3, 4, 5 Hurricanes to Strike the US Mainland Since 2017

**2,285**
Number of Structures Destroyed by Wildfire in Lahaina, Hawaii

**Figure 22:** United States natural catastrophe statistics | **Data and Graphic:** Gallagher Re

In the US, elevated industry losses were driven by high frequency and record severe convective storm (SCS) activity throughout the year. While large hail continued to produce the biggest share of SCS loss, notable tornadic activity, severe wind gusts, and heavy rainfall aided in pushing totals higher. SCS insured losses in 2023 reached USD60 billion. 2023 became only the third year on record to reach or exceed the USD40 billion threshold, alongside 2020 (USD44 billion) and 2011 (USD40 billion). In addition to SCS, notable events included the Lahaina Wildfire in Hawaii, billion-dollar-plus economic flood losses following record-setting 24-hour rainfall in Fort Lauderdale and New York City, Hurricane Idalia's Category 3 landfall in Florida, and expansive drought conditions which predominantly impacted the Southwest, Southern Plains, and Southeast.

- 2023 became the costliest insured year on record for US SCS with losses reaching USD60 billion
- 31 events with more than USD1 billion in economic losses, and 24 events with more than USD1 billion of insured losses
- Hawaii's Lahaina wildfire on Maui became the state's second costliest event on record, only behind Hurricane Iniki (1992)
- Exceptional rainfall in highly urbanized regions of Florida and New York/New Jersey led to billion-dollar economic losses
- Hurricane Idalia was the only hurricane to make landfall in the US, generating an industry loss of at least USD1.25 billion

### US SCS events dominated global insured loss totals

High frequency and impactful SCS events in the US dominated global insured losses in 2023, led by the hail sub-peril. Hail typically accounts for 50% to 80% of SCS claims in any given year. While there has been no discernible long-term trend in the frequency of SCS outbreaks, elevated losses in recent years have been aided by expanding urban footprints in hail prone regions and increased costs due to aging housing stocks.

Likewise, the average annual number of tornadoes has remained comparatively constant, however, the number of tornadoes on a per event basis has shown an increasing trend alongside a shift in geographical distribution. This has led to elevated tornado counts across highly vulnerable regions of the mid-South and Southeast, where a disproportionate number of manufactured homes are occupied. Concurrently, there has been an upward trend in the intensity of extreme precipitation associated with severe storm complexes, and the times of the year in which favorable atmospheric conditions for SCS outbreaks are present have extended amid a warming climate.

US Mainland
Top 10 Costliest Years: Insured Loss

**Severe Convective Storm**

| | | |
|---|---|---|
| 1 | 2023 | $59.7B |
| 2 | 2020 | $44.0B |
| 3 | 2011 | $40.1B |
| 4 | 2022 | $31.5B |
| 5 | 2021 | $29.1B |
| 6 | 2019 | $28.2B |
| 7 | 2017 | $26.6B |
| 8 | 2012 | $22.4B |
| 9 | 2016 | $22.0B |
| 10 | 2014 | $19.4B |

**Tropical Cyclone**

| | | |
|---|---|---|
| 1 | 2005 | $134.3B |
| 2 | 2017 | $68.3B |
| 3 | 2022 | $59.5B |
| 4 | 2021 | $42.8B |
| 5 | 2012 | $42.2B |
| 6 | 2004 | $39.6B |
| 7 | 1992 | $38.4B |
| 8 | 2008 | $31.6B |
| 9 | 2020 | $29.3B |
| 10 | 2018 | $23.1B |

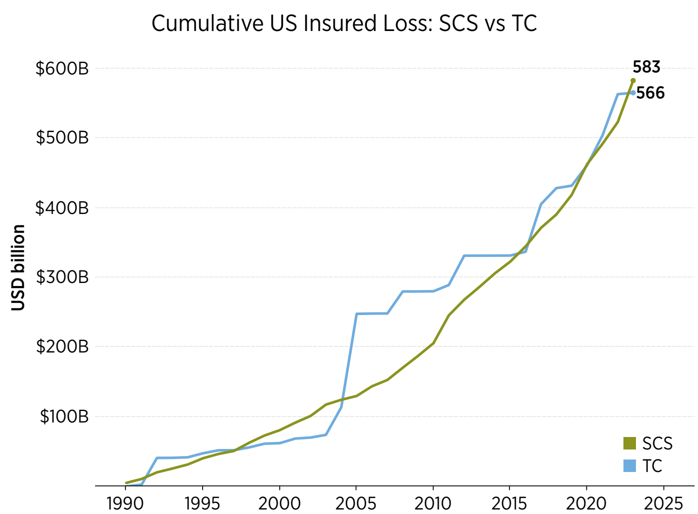



**Figure 23:** Top 10 costliest years for insured losses on the US mainland (top) and aggregated losses since 1990: severe convective storms and tropical cyclone
**Data and Graphic:** Gallagher Re

In 2023, the US preliminarily recorded at least 1,077 large hail reports (2+ inches/5+ centimeters). This neared the record of 1,079 set in 2011. Data from the Storm Prediction Center (SPC) similarly showed 2023 was an above average year for severe wind reports, and a slightly above average year for reported tornadoes (preliminary total of 1,294; of which 1,197 were confirmed through September 2023). The most violent tornadoes included two EF4s which touched down in Iowa and Mississippi, both in March — the country has not experienced an EF5 rated tornado since May 2013 in Moore, Oklahoma. Preliminary data indicated there were at least 26 deadly tornadoes in 2023, accounting for 83 fatalities — of which 47 occurred in March.

Amongst the high frequency of events throughout the peak SCS season, a pair of events in March/April proved to be the largest loss drivers. These included the early March outbreak which generated billion-dollar-plus industry losses in Texas and Kentucky, and the Mach 31–April 1 tornado outbreak, which included at least 147 tornado touchdowns — primarily across the Midwest and the Middle and Lower Mississippi Valley. The secondary severe weather season (which spans October to mid-December) brought a deadly tornado outbreak to the mid-south. Populated neighborhoods north of Nashville, including the community of Clarksville, experienced significant tornadic damage on December 9.

Substantial hail driven losses throughout the season were most impactful across the Southern Plains and Southeast with notable events impacting highly populated regions near Dallas Fort Worth, Texas and Little Rock, Arkansas. In Mississippi, the state's largest hailstone on record (4.88 inches/12.4 centimeters) was measured near Brooksville on June 14. Early August brought a billion-dollar-plus hail driven insured loss across the Minneapolis Metro region.

Gallagher Re has developed a suite of peril solutions, including Hail Score 2.0. This product enables informed decisions regarding pricing, exposure, and underwriting by providing historical replays, risk scores, and expected losses for locations within the US. The tool integrates 23 years of high-resolution daily radar hail swath data which then allows insurers to receive predictive analytics for parameters including hail size, claim frequency, and severity and damage ratios. Some benefits of the Hail Score include improved segmentation; ability to ensure rate adequacy for the SCS peril; manage accumulations to minimize potential impact of SCS events on earnings; and identify areas with growth opportunities.

### Multi-billion-dollar wildfire losses in Hawaii, a quieter season in the West

Despite a relatively quiet fire season in the West, the Lahaina Wildfire rapidly spread across the Hawaiian Island of Maui in early August and claimed at least 97 lives. The wind-driven fire destroyed no fewer than 2,285 structures and ranked among the state's costliest natural disasters on record, only behind 1992's Hurricane Iniki.

Total economic losses were estimated to approach USD6 billion, with insured losses likely reaching USD3.8 billion. The Maui fires reinforced that wildfire risk is not limited to certain areas of North America. Any ignited fire can spread and lead to extensive damage given favorable environmental conditions and vegetation. This is particularly concerning as more properties develop into the Wildland Urban Interface (WUI) or intermix, increasing the potential for costly and life-threatening impacts.


**Figure 24:** Wildfire perimeters in Maui (left), fire extent in Lahaina (middle), assessed damaged/destroyed properties in Lahaina (right) | **Data:** FEMA | **Graphic:** Gallagher Re

The US experienced ~55,550 reported wildfires in 2023, which impacted more than 2.6 million acres (1.05 million hectares). This was below the ten-year average of ~61,000 fires and 7.1 million acres (2.9 million hectares). Notable fire activity in the Southeast and Appalachians occurred during the spring and fall, resulting in loss of property and evacuations. In the West, the modest fire season was partially a result of anomalous snowpack and wetter than normal conditions, particularly in California. Outside of Hawaii, the costliest fire was the Washington State Gray Fire with reported industry losses nearly USD425 million.

To better communicate wildfire risk, Gallagher Re's Wildfire Hazard Score is founded on market-leading data for physically based fire propagation components and synthetic weather generated nationally, with hourly characteristics. The tools utilize 50,000 years of stochastic wildfires developed by the US Forest Service and focuses on geographical and environmental characteristics of the location, which we have identified as an accurate predictor of hazard. Out of USD1.2 billion of claims data used to validate the score, 97.4% of the loss came from locations that score "Moderate" or greater using our approach. The model has been approved by the California Department of Insurance for setting rates and underwriting rules including concentration factors.

### Increased frequency and severity of heavy precipitation events aids in costly floods

Amid notable instances of flooding and flash-flooding, the most impactful floods occurred in highly urbanized regions which included Fort Lauderdale in April and New York City in late September. In Fort Lauderdale, an unprecedented rainfall total of 25.60 inches (650 millimeters) fell in the span of 12 hours on April 12, with a 24-hour total reaching 25.9 inches (658 millimeters). According to data from the National Weather Service (NWS), these totals exceeded a 1-in-500-year rainfall accumulation (meaning an event of this magnitude has a less than 0.2% chance of occurring in any given year).

In late September, flooding and flash flooding likewise impacted regions of New York City and surrounding communities in New England. A state of emergency was declared in New York City and neighboring New Jersey, and significant damage to property and infrastructure was incurred. High intensity rainfall events continue to occur with a greater frequency as the environment and oceans warm. Impacts from such events are exacerbated when rains fall in urbanized regions that promote runoff, and where infrastructure may be ill equipped to handle the excessive water and changing climate.

Further damaging flooding episodes in the Northeast resulted from severe storms in July and a coastal low in mid- to late-December. The Northeast ranks among the regions in the country which have experienced the greatest increases in both frequency and severity of heavy precipitation events in recent years. In addition, the Fifth National Climate Assessment (NCA5), released in November 2023, highlighted that the Northeast will experience an increase in high tide flooding events in the coming decades. These trends continue to put more people and assets at risk of both coastal and inland floods and remain a focus for (re)insurers.

### Tropical cyclone industry losses lowest since 2015

Even with Hurricane Idalia's August landfall in Florida, industry losses from the 2023 North Atlantic hurricane season were the lowest on record since 2015. During the season, three Atlantic tropical systems made landfall in the continental US (Harold, Idalia, and Ophelia), of which Idalia was the only hurricane. This is another data point to remind us that while frequency is important, the location and intensity of events are the ultimate drivers of financial losses.

Idalia's 125 mph (200 kph) Category 3 landfall along Florida's Big Bend region and subsequent impacts generated an economic loss of nearly USD3.5 billion, of which USD1.25 billion was covered by public and private insurance entities. The latest data from the National Flood Insurance Program (NFIP) showed paid claims approaching USD220 million as of early December. Florida has recorded four landfalling hurricanes with at least 125 mph (200 kph) sustained winds since 2017 (Irma, Michael, Ian, and Idalia), and there have been 21 total such storms dating to 1851. The Florida insurance market remains a particular point of focus for the broader insurance industry, including notable challenges regarding the number of active carriers and how many policies are shifting to citizens insurance — the state-run insurer of last resort.

In the Eastern Pacific, former Hurricane Hilary and its remnants resulted in incessant rainfall across the West and Southwest, after making an August landfall in northern Mexico. In California, multiple locations experienced their wettest August day on record. This marked the first tropical system to impact the state since Nora in 1997.

### Drought: Third consecutive year with indemnity payments topping USD5 billion

Pronounced and multiyear episodes of meteorological (lack of precipitation) and hydrological (deficit in runoff or subsurface water reservoirs) drought have impacted regions of the US in recent years. 2023 marked the third consecutive year with drought indemnity payments topping USD5 billion. The total economic cost was estimated at USD14.9 billion, of which at least USD7.2 billion resulted in indemnity payments from the US Department of Agriculture's (USDA) Risk Management Agency (RMA) crop insurance program.

The year begun with lingering La Niña conditions and regionally historic drought across the West. In California, 98% of the state was affected by drought conditions at the start of January, when considering moderate drought or higher (D1+) according to data from the United States Drought Monitor (USDM). A series of powerful and damaging atmospheric river events which brought notable flooding and well above average snowpack to the Sierras, aided in erasing drought conditions. By the end of Q1, only 28% of the state experienced D1+ drought, and by the end of the year the entire state was free of D1+ conditions for the first time since 2020. Heavy rains returned in late December to California and the Pacific Northwest which resulted in a renewed flooding threat.

Conversely, severe drought worsened across the Plains/Southern Plains and Lower Mississippi Valley throughout 2023. By late-October, a record spatial area in Louisiana was impacted by the highest category D4 (Exceptional Drought) — records from the USDM extend back through 2000. Late summer and early fall drought conditions along the Gulf Coast stressed vegetation and aided in multiple out-of-control wildfires. Expanding summertime drought in the central corn belt impacted regional agriculture production during peak growing season.

## Looking Back at the Great Flood of 1993 (30-year anniversary)

2023 marked the 30-year anniversary of the 1993 Great Flood/Mississippi River Valley Floods. This remains the costliest economic flooding event on record for the US and ranks among the Top 5 insured US flood losses. Adjusted for 2023 dollars, the economic loss from the summer flooding would approach USD45 billion with insured losses of nearly USD27 billion.

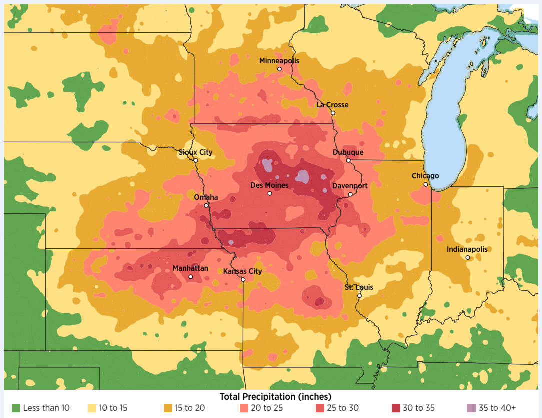


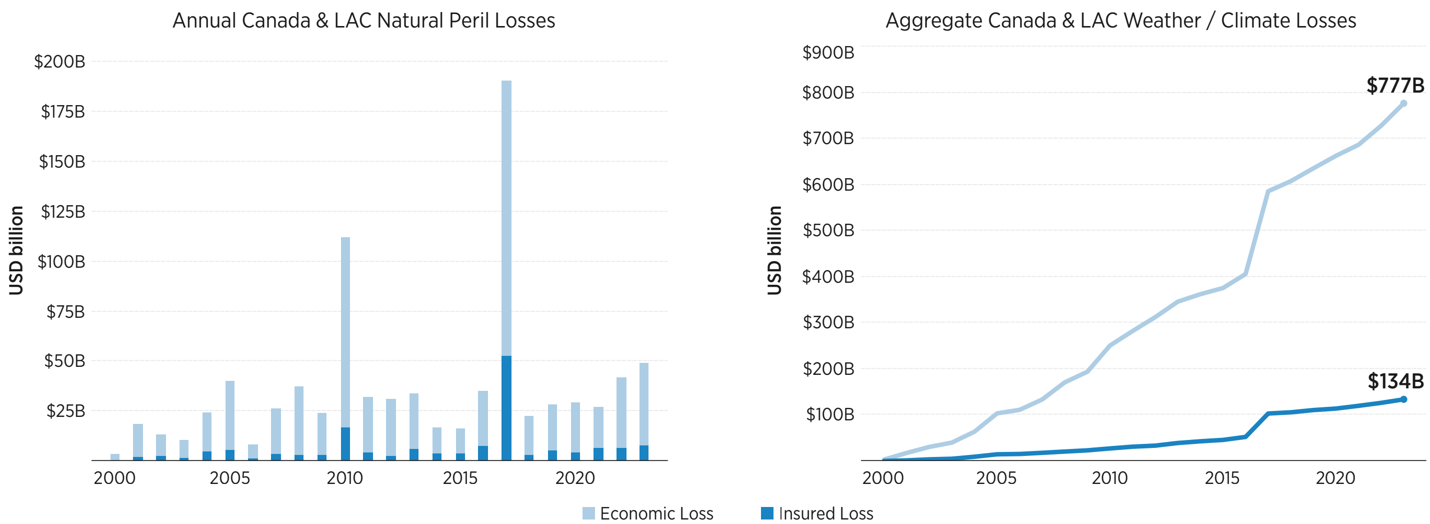

**Figure 25:** The Great Flood of 1993, total accumulated rainfall (inches) June–August | **Data:** PRISM | **Graphic:** Gallagher Re

The unprecedented riverine flooding followed episodes of torrential rainfall during the summer months (June to August) within the greater Mississippi River watershed. Soils were already saturated following wet conditions from the previous autumn into spring. Parts of Iowa, Nebraska, Kansas, Missouri, Illinois, Minnesota, and Wisconsin recorded the heaviest rain. Totals exceeded 20 inches (500 millimeters), with maximum values approaching 40 inches (1,000 millimeters). This equaled 150% to 300% of the average summer rainfall. The event was deemed a 1-in-500-year event (0.2% chance of annual occurrence). In total, more than 20 million acres (8.1 million hectares) of land was inundated and 50 people died.

In the years after the event, there were meaningful changes in how the US Army Corps of Engineers builds and maintains levees and other critical flood protection infrastructure. Some areas in the Midwest were transformed from farmland to floodplains. Other flood-prone properties and land areas in the years since have been sold back to the US government. It remains a flood event which other modern major US floods are compared against.

# Rest of the Americas: Canada/Latin America and Caribbean


**Figure 26:** Map of notable Canada and Latin America and the Caribbean events in 2023 | **Data and Graphic:** Gallagher Re




Notable Statistics in 2023

**18.5**

Millions of Hectares of Land Burned in Canada's Record Wildfire Year

**41.6**

Hottest Reliably Measured Temperature (°C) Ever Recorded in Peru (Oct 7, 2023)

**12.7**

Record Low Water Level (m) on the Rio Grande in Brazil During October

**105**

24-hour Rapid Intensification of Hurricane Otis (mph) Prior to Mexico Landfall

**Figure 27:** Canada and Latin America and the Caribbean natural catastrophe statistics | **Data and Graphic:** Gallagher Re

Elevated weather and climate driven economic and insured losses in both Canada and Latin American and the Caribbean (LAC) were influenced by a strengthening El Niño and augmented by the backdrop of a warming climate. Notable occurrences of stagnant or stuck weather patterns resulted in periods of regionally expanding drought, record heat, and flooding and flash flooding. This continued to direct additional attention and risk management solutions toward the flood and drought perils.

In Latin America, market losses were driven by Hurricane Otis' historic Category 5 landfall in Mexico on October 25 in Acapulco, and locally amplified by multiyear drought conditions. Canada's record wildfire season raised global awareness of climate driven risks and the importance of understanding the changing frequency and severity of fires.

- Hurricane Otis: Category 5 landfall in Mexico became the costliest insured event on record for the nation (USD4+ billion)
- Canada experienced an unprecedented area burned by wildfires; annual insured losses topped USD900 million
- Southern Brazil endured billion-dollar economic flooding losses in Q4, while multiyear drought persisted to the north
- Tropical moisture brought deadly flooding to the Caribbean, particularly Hispaniola, in mid-November

In Canda, economic losses of USD5 billion were 22% above the 21st century average, and insured losses of USD2.7 billion were 38% above the 21st century average. In LAC, economic losses of nearly USD44 billion were 40% above the 21st century average, and insured losses of USD4.9 billion were 14% above the 21st century average.

# Canada

A historic 18.5 million hectares (45.7 million acres) were burned by wildfire across Canada in 2023, with records extending back until 1959. This area far exceeded the previous record extent of 7.1 million hectares (17.5 million acres) burned in 1995. The fires displaced thousands of residents, damaged and destroyed property, caused a surge in greenhouse gas emissions, negatively impacted the lumber and tourism industries, and resulted in air quality alert days across both Canada and the northern US.

The fires were aided by persistent periods of above average temperatures and below average precipitation, particularly in western Canada. Many fires were concurrently ignited by lightning, including out-of-control wildfires which burned in Quebec in early June. Most of the insured losses were incurred in British Columbia and included the Grouse Complex Fires which generated significant damage to property near and in Kelowna and surrounding communities. In eastern Canada, the fast-moving Tantallon Fire that burned northwest of Halifax, damaged or destroyed at least 200 homes.

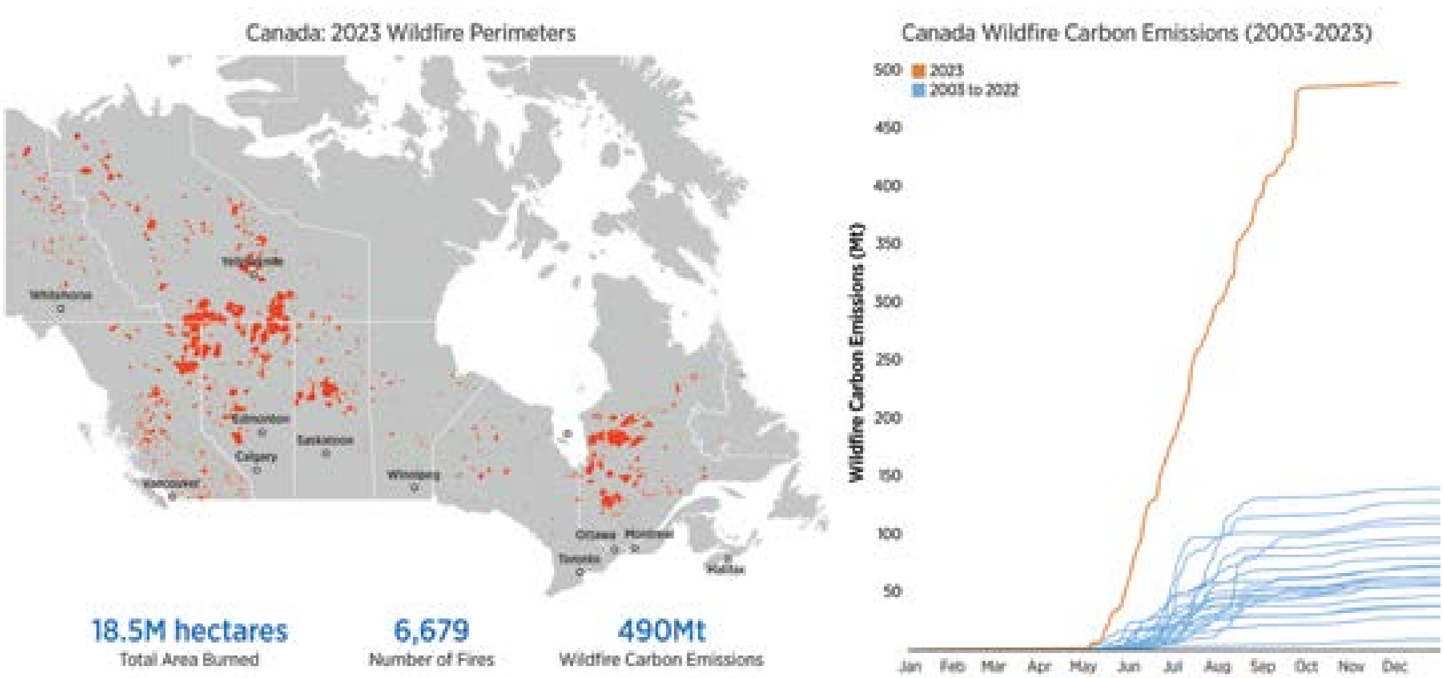



**Figure 28:** Canadian wildfire perimeters in 2023 (left), and annual cumulative daily wildfire carbon emissions (Mt) from 2003 to 2023 (right)
**Data:** CWFIS / CIFFC / ECMWF | **Graphic:** Gallagher Re

According to Natural Resources Canada, many provinces implemented a “let it burn” firefighting strategy if there was no imminent risk to life and property. Such a strategy is conducive to further out-of-control fires as climate change makes environmental conditions increasingly susceptible to fire growth and erratic behavior. El Niño conditions are expected to persist into the spring and tend to bring milder conditions to western Canada, this could potentially influence the 2024 wildfire season.

Beyond the wildfire costs, the rest of Canada’s dominating perils were damage from SCS, winter weather, or flooding. Most notably, an early spring ice storm, which impacted the most populous provinces of Ontario and Quebec in April, knocked out power to nearly one million residents and generated hundreds of millions (USD) of market losses.

## Mexico

In Mexico, Hurricane Otis made a catastrophic Category 5 landfall in the Guerrero State near Acapulco on October 25. After exhibiting an unexpected period of explosive rapid intensification, Otis became the first Category 5 and the strongest landfalling hurricane along Mexico’s Pacific coast in recorded history. At landfall, maximum sustained winds in the compact storm remained at 165 mph (270 kph). Otis rapidly intensified by an astonishing 105 mph (165 kph) in a 24-hour period upon approach to land. This magnitude of rapid intensification had only been exceeded in the Eastern Pacific basin by Hurricane Patricia in 2015. Rapid intensification is defined by an increase in maximum sustained winds of at least 35 mph (55 kph) in a 24-hour period.

Hurricane Otis became both the costliest economic and insured event on record for the Mexican market, with insured losses reaching USD4 billion. Estimates by government officials indicated that at least 270,000 homes and hundreds of hotels were damaged or destroyed. In Acapulco, 80% of the city’s hotels reported varying degrees of damage.

The estimated insured losses from Otis were primarily driven by wind damage, with contributions from inland flooding and instances of storm surge. Given the scale of damage to high-end commercial properties, this was a notable driver of the insured payouts. Impacts from Otis were enhanced by the storm’s sudden intensification, which gave residents and tourists in Acapulco and surrounding communities little time to prepare or evacuate. At least 52 deaths were confirmed.

An active Pacific hurricane season resulted in five named storms making landfall along Mexico’s Pacific coast (Hilary, Max, Lidia, Norma, and Otis). Lidia likewise underwent a period of rapid intensification prior to making a Category 4 landfall in Jalisco on October 10. With maximum sustained winds of 140 mph (225 kph), Lidia tied for Mexico’s third strongest landfalling Pacific hurricane on record.

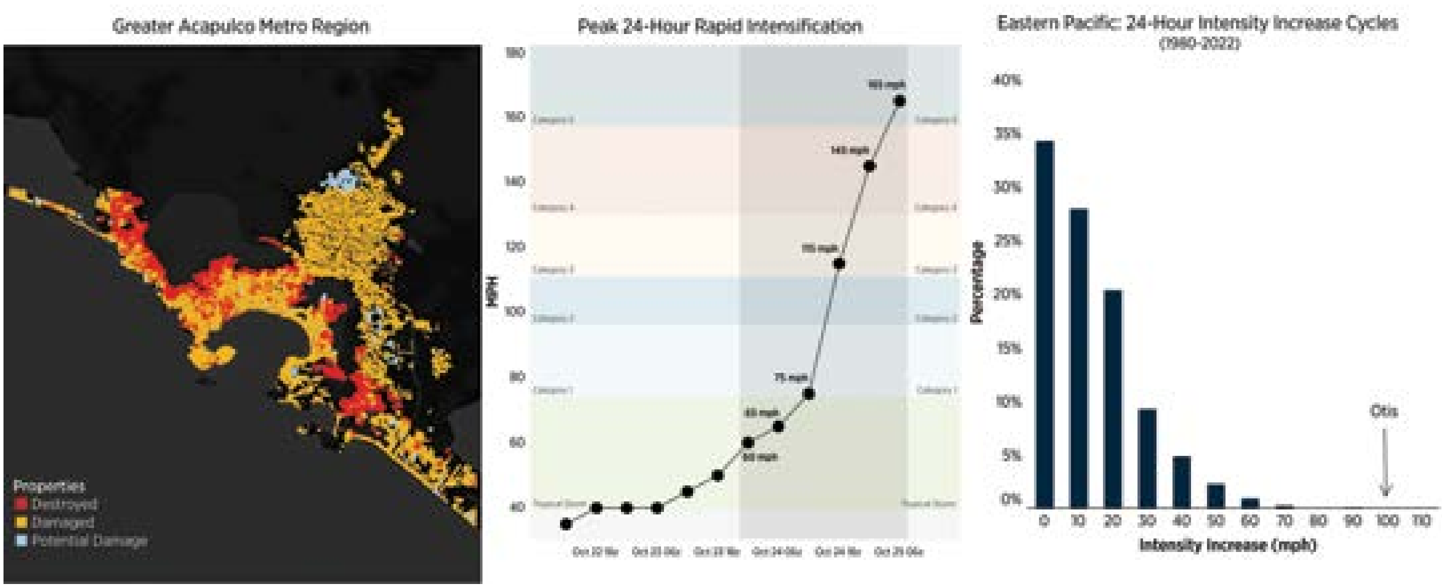



**Figure 29:** Hurricane Otis damage in Acapulco (left), rapid intensification cycle (middle), historical context showing rarity of intensification cycle in the East Pacific (right)
**Data:** NOAA/NHC | **Graphic:** Gallagher Re

# South America

### Droughts and floods

El Niño's influence in South America was marked by episodes of flooding along the northern Pacific Coast and in Brazil's southern growing regions, notably during Q4. Conversely, central and northern states of Brazil and surrounding countries continued to endure multiyear drought evidenced by historic impacts across the Amazon and La Plata Basins.

In late October, the Rio Grande (a tributary of the Amazon) reached a record low water level of 41.7 feet (12.7 meters) at Manaus, Brazil with records dating back until 1902. This had notable economic impacts on shipping, agriculture, and human health. The record low was marked drop from the record high level of 99 feet (30.2 meters) reached in 2021. Drought generated losses of nearly USD18 billion in Brazil, Argentina, and Uruguay alone, most of which went uninsured and was incurred due to impacts in the agriculture, livestock, and transportation sectors.

In contrast, incessant rainfall led to flooding and flash flooding across Brazil's Rio Grande do Sul and Santa Catarina states in October and November. The floods generated significant economic impacts on property and stressed vital growing regions. Beneficial rains fell across several of the driest regions in Brazil and Argentina in the first days of 2024.

In Chile, copious rainfall resulting from a series of atmospheric river events in August prompted a state of catastrophe and generated an agricultural-driven billion-dollar-plus economic loss. Chile was impacted by a similar event in June. Flooding was enhanced as these events and resulting inundation followed a regional multiyear drought.

### Wildfires threaten lives and ecosystems

Amid episodes of record-breaking heat and regionally dry conditions, wildfires resulted in damage to ecosystems and homes, loss of lives, and displaced thousands of people across South America. In Chile, nearly 430,000 hectares (1.06 million acres) burned during the 2022/23 season (July to June), this ranked as the second most active season in terms of area affected since at least 1964. Economic damages reached into the hundreds of millions (USD). Wildfires likewise impacted regions of Argentina and Bolivia in Q4.

### Caribbean: Quiet hurricane season, tropical moisture brought flooding in Q4

An episode of tropical moisture resulted in flooding and flash-flooding across the Caribbean in mid-November. Hispaniola, eastern Cuba, and Jamaica were most impacted. In the Dominican Republic, 24-hour rainfall totals through November 17 reached and exceeded 10 inches (250 millimeters) in localities of the National District and San Cristóbal. The devastating flooding claimed at least 30 lives and damaged or destroyed more than 7,400 homes.

# EMEA

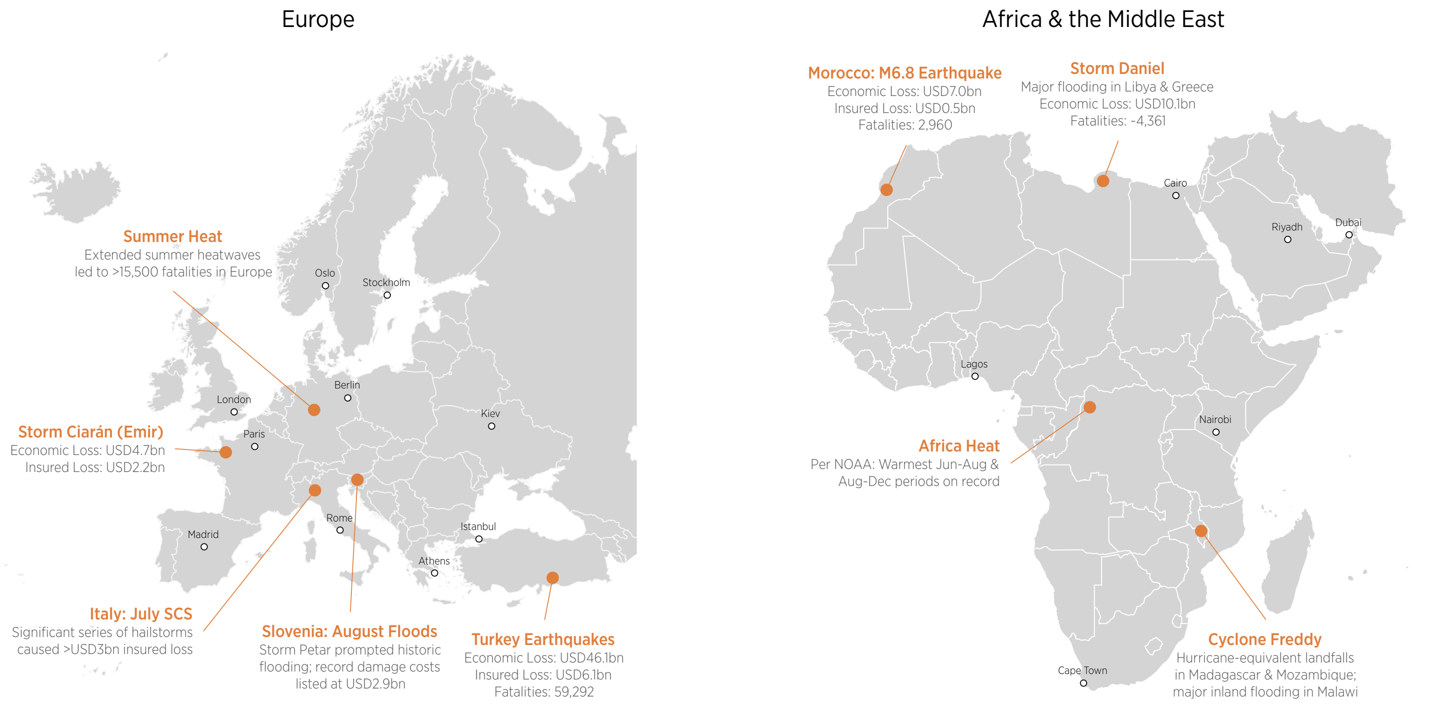
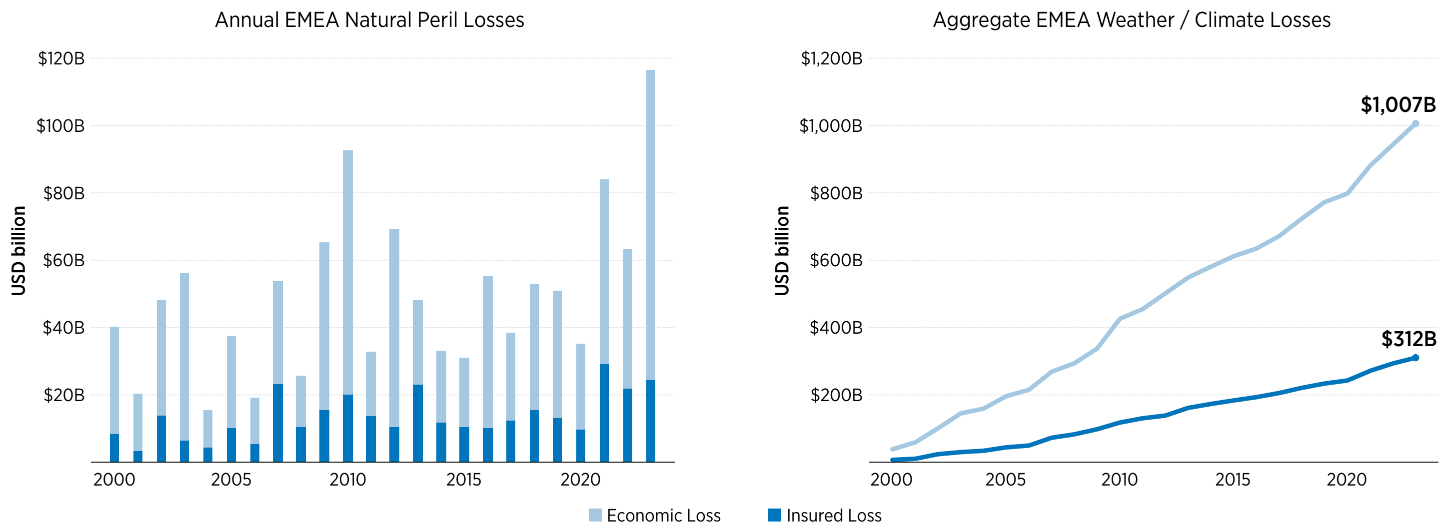



**Figure 30:** Map of notable Europe, Middle East, Africa (EMEA) events in 2023 | **Data and Graphic:** Gallagher Re




Notable Statistics in 2023

**19**
Record Europe Hailstone Size (cm) in Italy on July 24

**1,096**
Amount of Rainfall (mm) Recorded at Zagora, Greece During Storm Daniel

**7.8**
Magnitude of the Largest Earthquake in Turkey During February 2023 Sequence

**35**
Days That Cyclone Freddy Remained a Tropical Cyclone; A New Global TC Record

**Figure 31:** Europe, Middle East, Africa (EMEA) natural catastrophe statistics | **Data and Graphic:** Gallagher Re

EMEA endured above average economic and insured losses in 2023. Much of the region experienced notable weather and climate driven catastrophes of which record hail and flooding proved most impactful. While perhaps not as extreme as 2022, the summer of 2023 was marked by a series of heat waves, the most intense of which resulted from atmospheric blocking patterns. The unofficial death toll from heat-related incidents likely exceeded 15,500.

Losses were heavily driven by the February Turkey earthquake sequence, which was the deadliest and largest economic and industry loss event of the year. In Europe, exceptional flooding, dangerous and prolonged heat, record hail, and an active start to the 2023/24 windstorm season further aided in an elevated economic and humanitarian toll. Storm Daniel, fueled by anomalously warm waters in the Mediterranean Sea, caused devastating flooding in both Greece and Libya. Daniel became the deadliest weather-related event (excluding heatwaves) of the year.

- 13 events with more than USD1 billion in economic losses, and six events with more than USD1 billion of insured losses
- The February Turkey earthquake sequence claimed 59,259+ lives and generated an insured loss of more than USD6.1 billion
- Europe: SCS outbreak sequence (July 17–25) resulted in nearly USD6 billion in economic losses, most due to hail in Italy
- Africa: Powerful magnitude 6.8 earthquake left extensive damage in Morocco in September
- Storm Daniel caused devastating flooding in Greece and Libya, at least 4,361 fatalities were reported
- Storm Ciarán (Emir) generated record wind gusts and widespread damage across France's Normandy region in November

# Europe

**Turkey earthquake: Costliest economic natural catastrophe sequence in 2023**

The devastating Turkey and Syria earthquake sequence in February, including the M7.8 main shock, resulted in a humanitarian emergency and ranked as the largest insured and economic event in 2023. The earthquake swarm generated economic losses which approached USD46.2 billion, in line with high-end estimates released by the World Bank. Public and private industry losses approached USD6.1 billion of that total, a sizeable portion of which was covered by the Turkish Catastrophe Insurance Pool (TCIP). This ranked as the largest industry loss for the Turkey market on record. Additional indirect losses — such as lost productivity, health, and reconstruction costs — resulted in a further financial cost that reached into the tens of billions (USD).

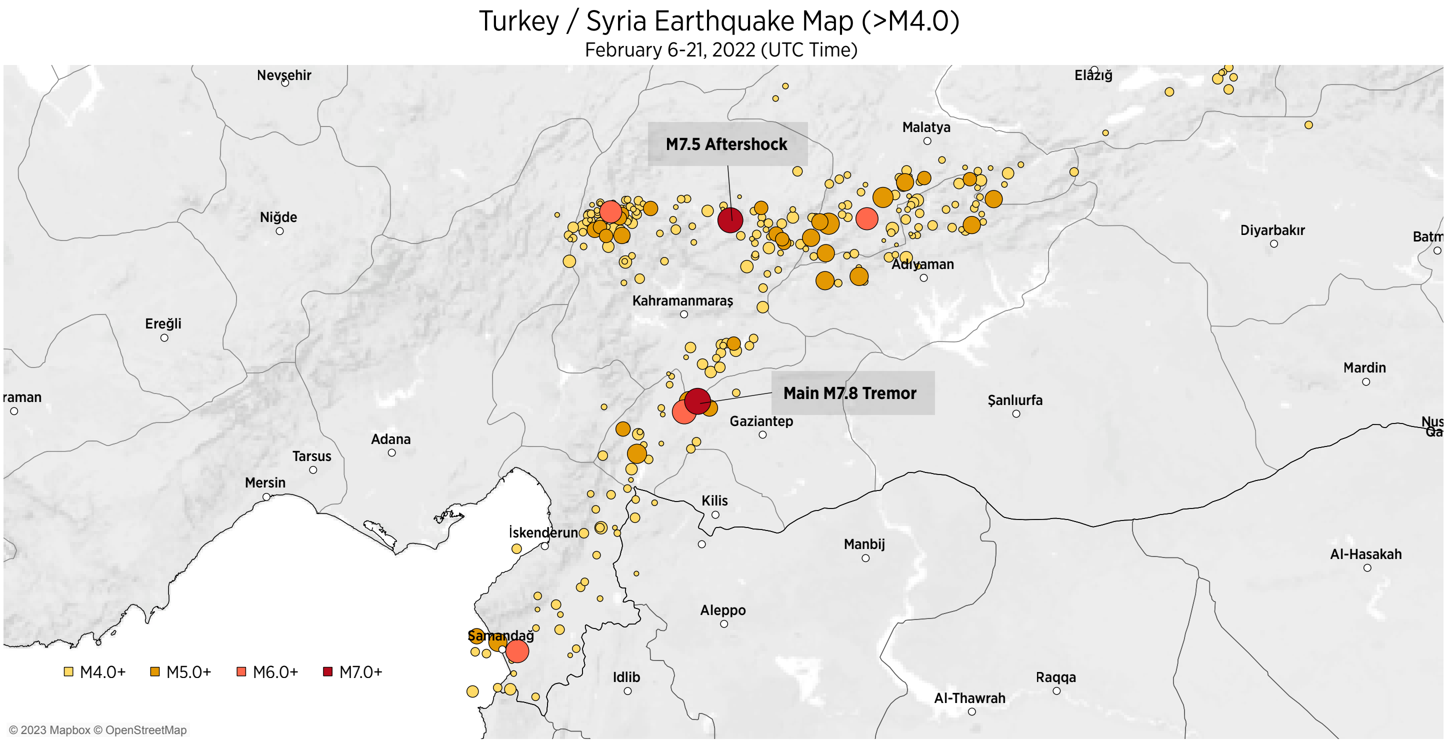



**Figure 32:** February Turkey / Syria earthquake sequence (>M4.0) from February 6-21, 2023 | **Data:** USGS | **Graphic:** Gallagher Re

### Floods highlight existing protection gap

Flooding and flash-flooding continued to grab headlines across Europe throughout the year. This included catastrophic flooding in Italy's Emilia-Romagna region in May Storm Minerva (Chappu) and in the Tuscany region in November (associated with Ciarán/Emir). Historic flooding and flash-flooding likewise occurred in Slovenia (Petar/Zacharias) and the Nordics (Hans) in August; across eastern Greece in September (Daniel and Elias); and in the UK in October (Babet and Aline). The year ended with incessant December rainfall and a renewed flooding threat across western Europe, notably in northwest Germany.

Greece was particularly impacted by extreme events in 2023 as record heat and damaging wildfires were followed by unprecedented flooding primarily resulting from Storm Daniel, which inundated eastern Thessaly. In Scotland, Storm Babet prompted the highest level "red warnings" for rainfall across eastern regions, the first such warnings issued since 2020. The storm brought heavy rainfall and flooding to the UK and Ireland before impacting the Nordics between October 17–21.

While European floods resulted in notable claims payouts, most of the damage was left uninsured. This highlights the prominent protection gap that continues to exist in the impacted countries. This is particularly important as the climate risk associated with flooding across Europe continues to grow, owing partially to the fact that warmer air can hold increasingly more moisture.

### July SCS becomes Italy's costliest weather and climate event

In mid- to late-July a prolonged stretch of near daily SCS outbreaks impacted regions in western, central, and southern Europe. The severe weather was driven by contrasting air masses along the northern periphery of a ridge of high pressure, colloquially known as a heat dome, and aided by a series of frontal boundaries interacting with warm air and moisture pulled from the Mediterranean Sea.

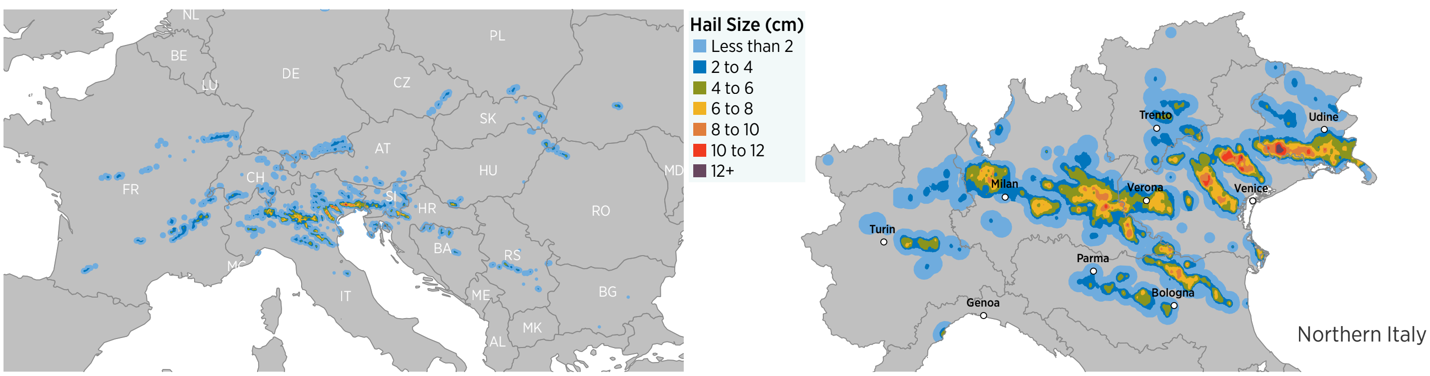



**Figure 33:** Hail swaths in Europe (left) and northern Italy (right) from July 18-25, 2023 | **Data:** ESSL/ESWD | **Graphic:** Gallagher Re

Most of the losses generated by the July 17 to 25 outbreak(s) were driven by large hail, of which a majority occurred in northern Italy. Industry losses during both the July 17 to 19 and July 20 to 25 events ranked among the largest weather-related losses on record for the Italian market; combined insured losses exceeded USD3 billion. A 7.48 in (19 cm) hailstone fell in Azzano Decimo of the Friuli-Venezia Giulia region of Italy on July 24, setting a new European record for largest hail (this broke the record set by an Italian hailstone several days prior on July 19). Research from the European Severe Storms Laboratory (ESSL) indicated northern Italy is among the regions in Europe which had experienced a marked uptick of large hail (2+ inches/5+ centimeters) since the 1950s, aided by increasing humidity in the lower atmosphere.

### Storm Ciarán (Emir) and an active start to the windstorm season

An active start to the 2023/24 European windstorm season featured Storm Ciarán (Emir) in the first days of November. Ciarán affected western and southern Europe, with the greatest losses occurring in France, Italy, and the UK. Several absolute wind records were broken in France's Britanny region with a maximum gust of 128 mph (207 kph) recorded at Pointe du Raz. Industry losses in France alone were expected to exceed USD1.6 billion. Frontal boundaries associated with Ciarán, in tandem with a secondary area of low pressure, further brought copious rainfall and flash-flooding to Italy's Tuscany region. Reaching a minimum central pressure of 953.3 millibars on November 2, Ciarán ranked as the strongest storm observed for the month of November across England and Wales (a lower pressure is indicative of a more powerful storm).

Damages in France were compounded in subsequent days by the passage of Domingos (Fred), which generated hundreds of millions (USD) in additional industry losses. The pair of low-pressure systems resulted in notable flooding across northeast regions of the country.

While the future annual frequency of European windstorms remains uncertain, continued greenhouse gas emissions and a warming climate increase the odds of more intense and rapidly strengthening storms in the years ahead.

# Africa and the Middle East

### Morocco earthquake

Losses in Africa were led by the September magnitude 6.8 Marrakesh-Safi earthquake with an epicenter in Morocco's Atlas Mountains. The earthquake claimed nearly 3,000 lives and generated an economic loss of at least USD7 billion, of which over USD500 million was insured. A sizeable portion of the industry loss was covered by a parametric insurance scheme placed by Gallagher Re. This ranked as the strongest earthquake to impact Morocco since 1900.

### Tropical cyclones and flood risks increasing amid a warming climate

In Q1, Cyclone Freddy remarkably traversed the entirety of the Indian Ocean, became the first storm to undergo seven rapid intensification cycles, and preliminarily holds the record as the longest-lived tropical cyclone globally. Freddy ranked as one of the wettest tropical storms on record for Mozambique. Climate change and warming sea surface temperatures are playing a role in making tropical cyclones wetter and more intense. Localities in Madagascar and Mozambique have been particularly susceptible to tropical cyclone landfalls in recent years. In 2022, four tropical cyclones made landfall in Madagascar between January and March (Ana, Dumako, Batsirai, Emnati).

Copious rainfall and exceptional flooding associated with Storm Daniel's landfall in northern Libya on September 10 created a humanitarian crisis as more than 4,360 fatalities were recorded by the World Health Organization (WHO). Catastrophic damage and loss in Libya's Derna District were aided by the breach of two dams. The City of Derna was particularly affected, as entire neighborhoods were swept away by floodwaters. The breaches in Libya's dams highlighted the importance of understanding multiple hazards associated with excessive rainfall, in tandem with the urgent need to inspect and modernize infrastructure to meet the needs of both the current and future climate.

In the Horn of Africa, one of the worst droughts in decades gave way to and heightened impacts resulting from exceptional flooding and flash-flooding in Q4, with the heaviest rains occurring in October and November. The flooding was enhanced by a positive Indian Ocean Dipole (IOD) and further amplified by El Niño. By December, more than 404 flood related deaths were recorded in Somalia, Kenya, Ethiopia, Burundi, Malawi, and Tanzania. Over two million people were displaced, and thousands of homes were inundated. In Somalia, it was estimated 4.4 million acres (1.8 million hectares) of cropland was impacted. The Horn of Africa regularly experiences two annual rainy seasons, a primary season between April and June and a shorter season between October and December. This region is one of the world's most vulnerable to climate change.

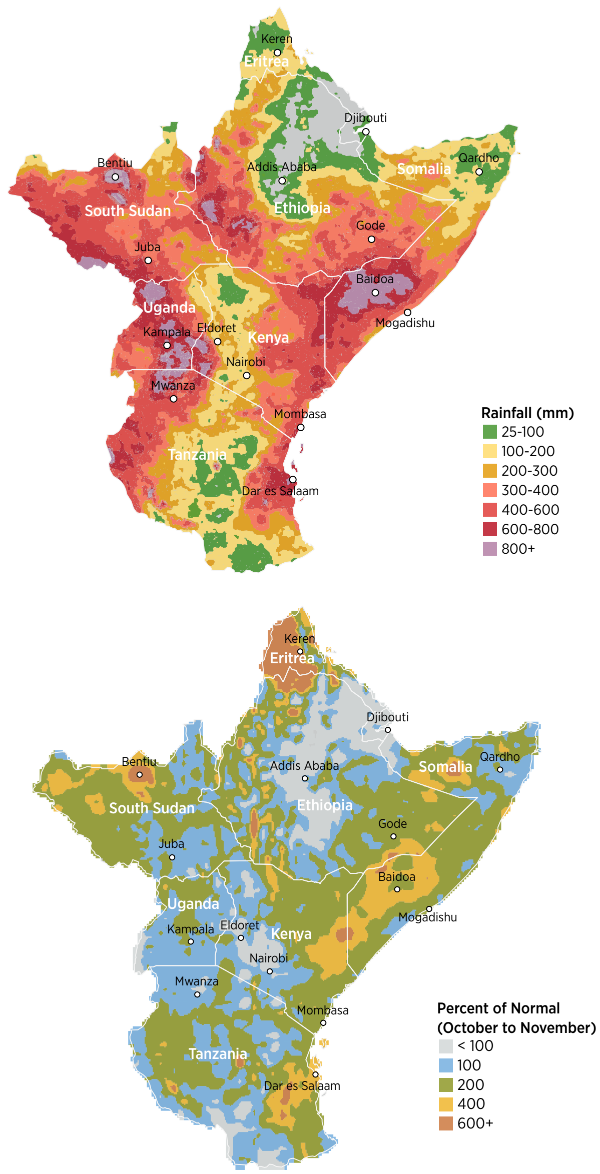



**Figure 34:** Eastern Africa October to November satellite derived rainfall (mm), and percentage of normal rainfall (compared to 1991–2020 ERA5 climatology)
**Data:** NOAA/GPM/ECMWF/ERA5 | **Graphic:** Gallagher Re

## Impact of the Indian Ocean Dipole (IOD)

The Indian Ocean Dipole (IOD) is a phenomenon which influences the weather and climate of countries surrounding the Indian Ocean basin. The IOD is defined by a difference in sea surface temperatures (SSTs) between two poles, a western pole in the Arabian Sea and an eastern pole south of Indonesia. The east to west contrast in SSTs alters the regional wind, temperature, and rainfall patterns. The positive phase of the IOD, such as seen during the second half of 2023, is characterized by colder than normal ocean temperatures in the eastern equatorial Indian Ocean and warmer than normal SSTs in the western Indian Ocean. The IOD typically peaks in September to November.

While the gradient between the western and eastern tropical Indian Ocean that is typical of a positive IOD is still apparent, as of this publication, the strength and extent of the cooling in the eastern pole has reduced in tandem with the strength of the anomalous warmth in the western pole.

A positive IOD has historically brought floods to eastern Africa, and droughts and increased risk of bushfires to regions of eastern Asia and Australia. Concurrently, El Niño conditions, indicated by warmer than normal SSTs in the tropical Pacific Ocean, tend to magnify the influence of a positive IOD event.

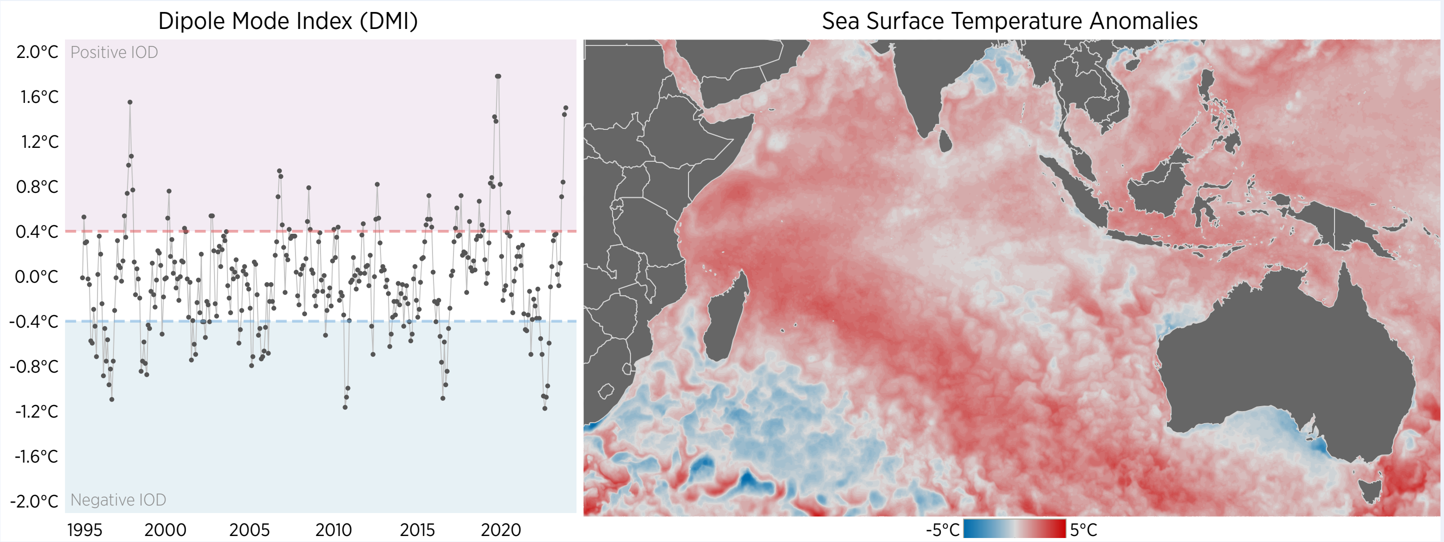



**Figure 35:** Monthly Indian Ocean Dipole Mode Index since 1995 and Sea Surface Temperature Anomalies on January 1, 2024 | **Data:** NOAA | **Graphic:** Gallagher Re

# APAC

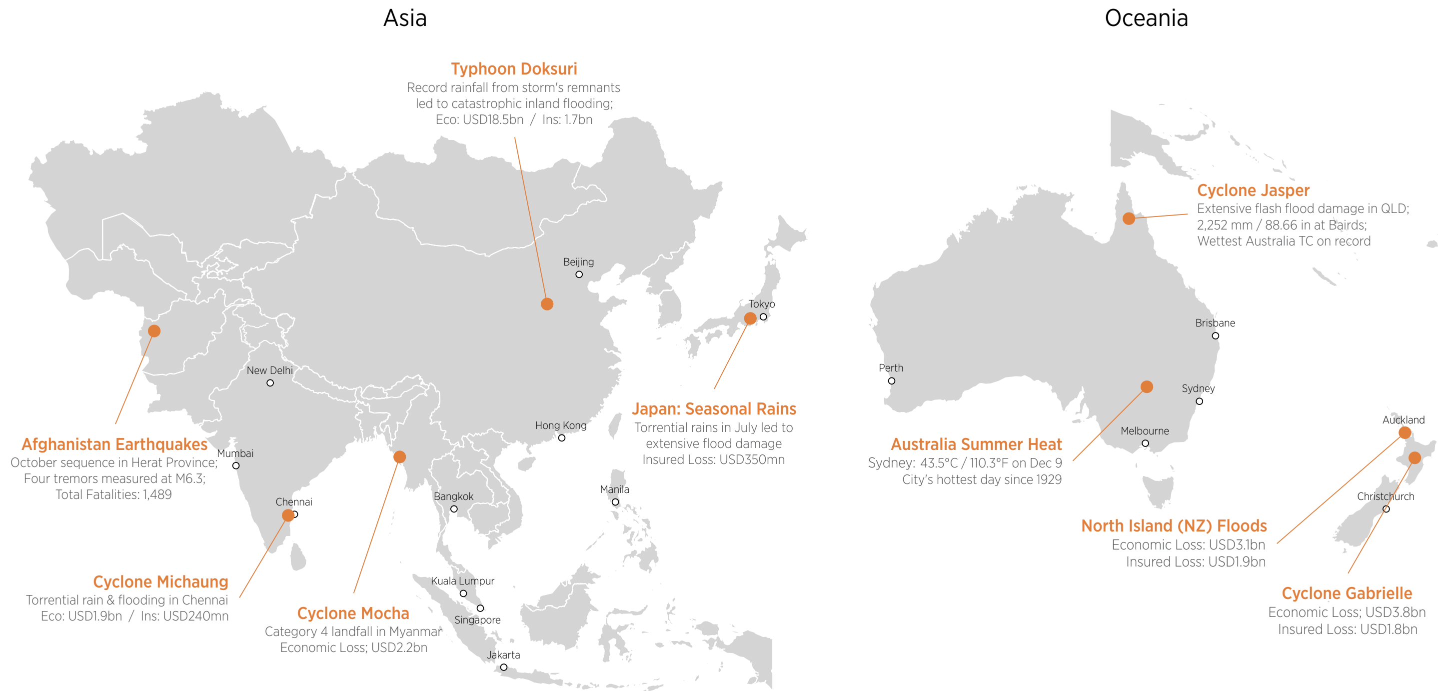
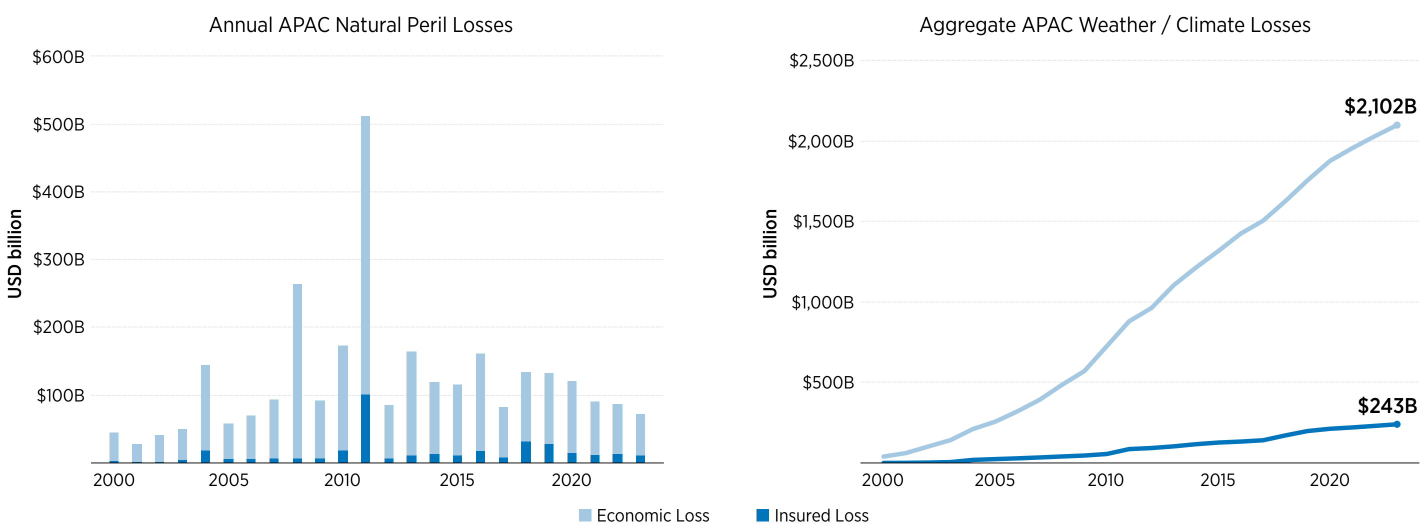



**Figure 36:** Map of notable Asia-Pacific (APAC) events in 2023 | **Data and Graphic:** Gallagher Re




## Notable Statistics in 2023

**5**

Number of Asian Countries w/ All-Time Heat Records Set in 2023
Countries: CN, TH, VN, LA, SG

**17**

Number of Named Storms in the 2023 NW Pacific Typhoon Season; Third-Fewest Since 1980

**744.8**

Amount of Rainfall (mm) in Beijing via Remnants of TY Doksuri; Heaviest Total Since 1883

**2**

Weeks Between New Zealand's Two Costliest Weather Disasters On Record

**Figure 37:** Asia-Pacific (APAC) natural catastrophe statistics | **Data and Graphic:** Gallagher Re

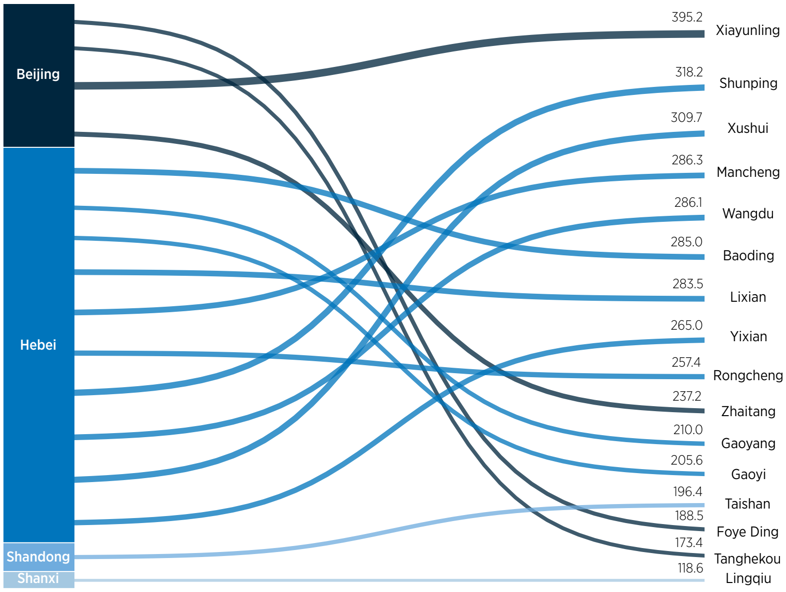
The Asia-Pacific (APAC) region experienced below-average catastrophe losses in 2023, largely due to a subdued typhoon season (with a limited number of landfalls) and reduced seasonal flood losses (aided partly by the effects of El Niño). While economic and insured losses were below the 21st century average (-42% and -33% respectively), they were in line with expected losses during an El Niño year. The region experienced three individual events which topped USD1 billion for insured losses in New Zealand (2) and China (1). In total, there were 13 billion-dollar-plus economic loss events in APAC.

- Overall natural catastrophe losses in APAC were below normal during all four quarters
- Water-related hazards (flooding and tropical cyclone remnants) were a dominant driver of losses across Asia
- Two Jan./Feb. events in New Zealand (North Island/ Auckland floods and Cyclone Gabrielle) equaled 2% of New Zealand's GDP
- Typhoon Doksuri and seasonal floods in China combined accounted for more than 40% of economic losses in Asia
- Sydney sweltered above 40°C/104°F in record Q4 heat; elevated risk of bushfire continues into 2024

# Asia

Typhoon Doksuri was preliminarily the costliest typhoon on record to impact mainland China, with much of its damage occurring due to inland flooding as the system and its remnants combined with other synoptic conditions to trigger prolific rainfall. The period between July 29 and August 1 left Beijing inundated by its heaviest rainfall since 1883. Multiple stations in neighboring Hebei likewise broke rainfall records, including a 1,003 mm (39.5 inch) rainfall observed in Lincheng County during a 72-hour period. The combination of the urban heat effect, remnants of Typhoon Doksuri, moisture advection from Typhoon Khanun, and the local topography combined to enhance available moisture that initiated the extreme event.

Typhoon Haikui, whose remnants broke rainfall records in Hong Kong and Shenzhen a month later, was likewise a notable storm for the region. Typhoon Koinu set both daily and 24-hour rainfall records for Hong Kong in October. According to the China Meteorological Administration (CMA), while there were fewer landfalling typhoons in China/Taiwan in 2023, the average windspeeds at landfall from the six typhoons were stronger than average by 33 kph (20 mph) — this increased intensity was likely fueled or sustained by warm sea surface temperatures.



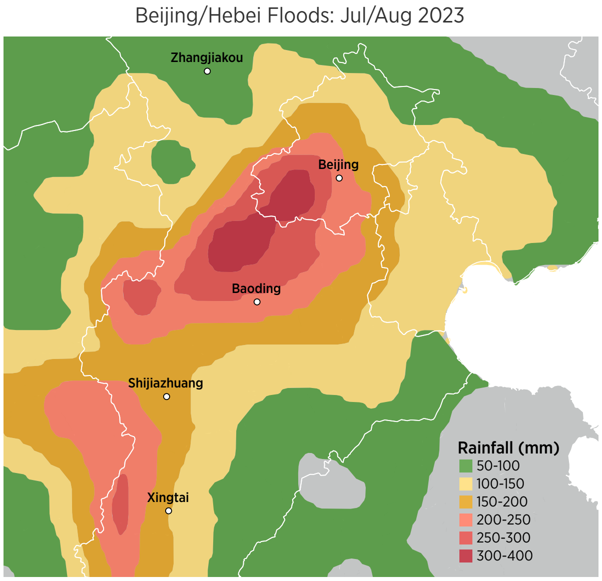




**Figure 38:** Beijing/Hebei July and August 2023 Floods: Peak 24-hour rainfall records broken (left) and regional rainfall map (right)
**Data:** CMA and ERA5 | **Graphic:** Gallagher Re

A series of earthquakes during Q4 affected parts of Afghanistan, Nepal, and China. The tremors resulted in at least 1,700 fatalities. The December Jishishan earthquake was China's deadliest in a decade, and concurrently damaged or destroyed more than 222,000 homes. Liquefaction and sand boils (water welling up through a pressurized sand layer) were observed in villages in Qinghai. Houses constructed with clay or mud in impoverished regions impacted by the earthquakes were at an increased risk from the deadly temblors.

# Oceania

The most significant events in Oceania both occurred in New Zealand within a two-week stretch in late January and early February 2023. First, during a 48-hour period beginning on January 27, Auckland was inundated with substantial rainfall and subsequent flooding. The event resulted in widespread damage to property, infrastructure, and agricultural interests. Rainfall levels were calculated as a 1-in-200-year event (meaning a 0.5% chance of occurring in any given year), per the New Zealand National Institute of Water and Atmospheric Research (NIWA). An extended state of emergency was declared in Auckland, the first declaration in the city since the current system was implemented in 2002. Prior to the storm, the soils in the region were already saturated following an anomalously wet January, due to rains from Cyclone Hale and lingering impacts of La Niña.

Just two weeks later, Cyclone Gabrielle and its remnants brought damaging wind gusts and renewed flooding to the country. This prompted a nationwide state of emergency. The cyclone caused extensive damage from Gisborne to Wairarapa. The event had a major impact on the farming industry as large swathes of agricultural and pastoral land were inundated. The Ministry for the Environment reported more than 300,000 landslides resulting from the event, mainly along the east coast of the North Island.

Cyclone Gabrielle became New Zealand's costliest non-earthquake event, with the Treasury estimating the repair bill upwards of NZD9 billion (USD5.6 billion). It was likewise the costliest tropical cyclone in the Southern Hemisphere. The name Gabrielle was retired from the Australian region cyclone list. Marine heatwave enhanced rainfall and antecedent flood episodes in the North Island exacerbated the speed at which rivers rose following the cyclone.

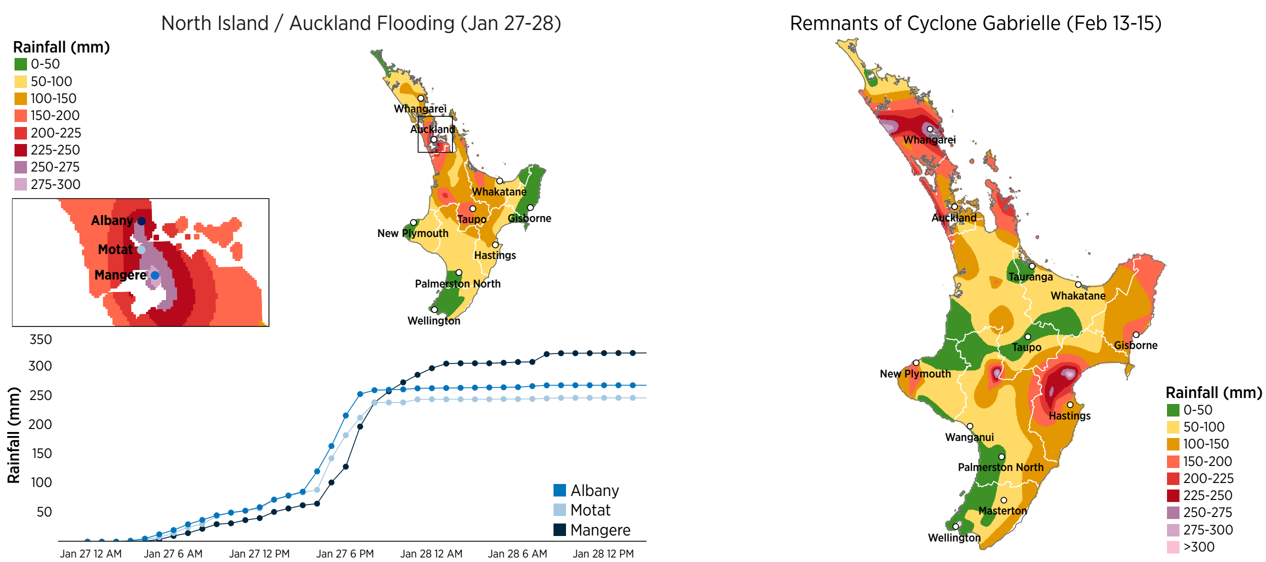



**Figure 39:** North Island/Auckland rainfall map and hourly station totals on Jan. 27–28 (left) and rainfall map from the remnants of Cyclone Gabrielle in the North Island (right)
**Data:** NIWA | **Graphic:** Gallagher Re

In Australia, Cyclone Jasper brought torrential rainfall to North Queensland in December. A peak rainfall of 2,252 millimeters (88.7 inches) at Baird near the Daintree River was aided by the slow translation speed of the cyclone and enhanced by the local terrain. If verified, this would make Jasper the wettest tropical cyclone to impact Australia on record. The deluge left extensive damage, including at Cairns Airport where planes were flooded after waters overtopped the airport levee. The Insurance Council of Australia (ICA) declared this as a "catastrophe", and the cyclone was the fifth to be covered by the Australian Reinsurance Pool Corporation (ARPC).

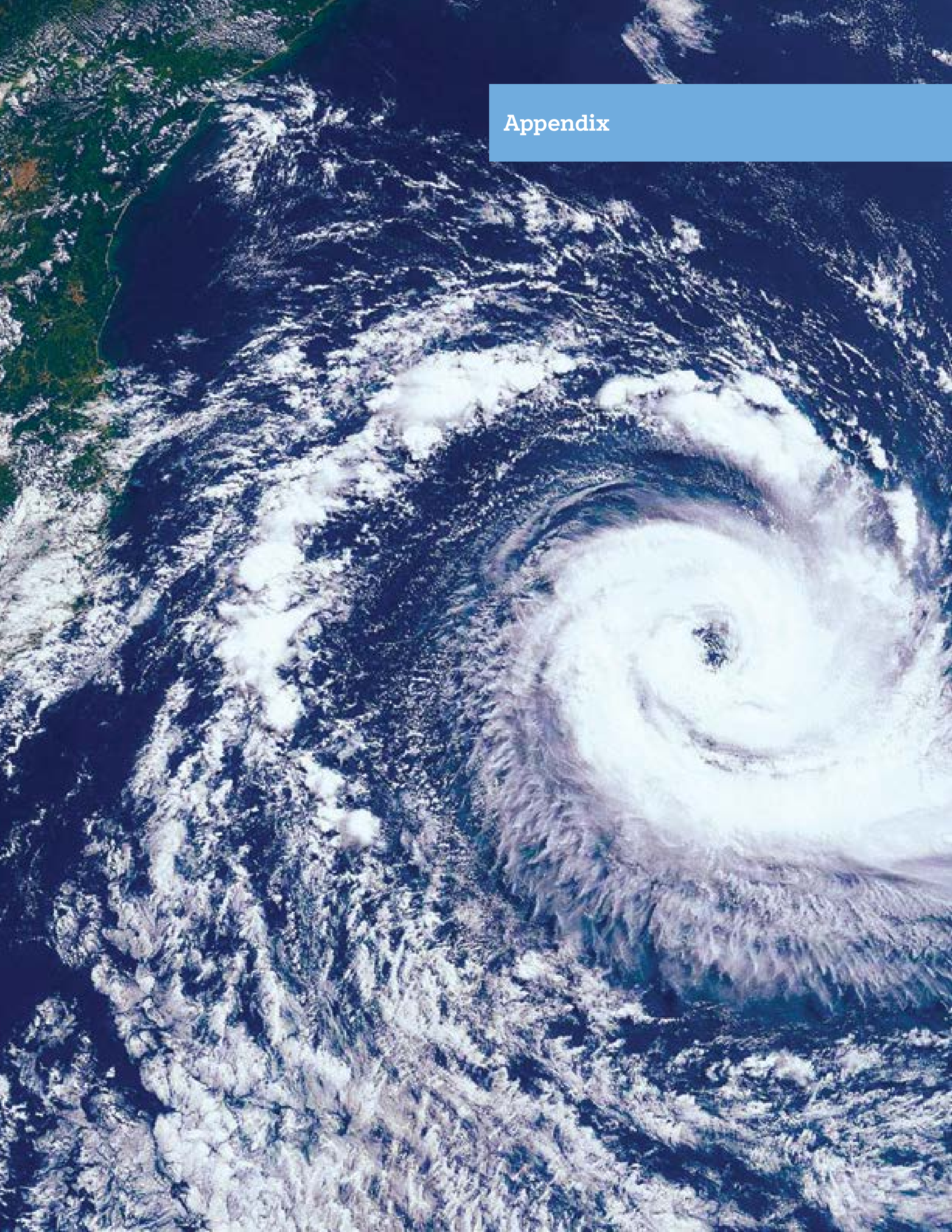
Another insurance catastrophe was declared by ICA for a series of SCS outbreaks that extended from Christmas 2023 into early January 2024 in parts of Queensland, New South Wales, and Victoria. Most claims were filed in the Gold Coast region. Strong winds, hailstones, and torrential rain left 10 people dead.

## Looking Back at the Great Kantō Earthquake (100-year anniversary)

The 2023 Japan Disaster Prevention Day (September 1) marked 100 years since the 1923 Great Kantō earthquake. Together with Tohoku University's International Research Institute of Disaster Sciences (IRIDeS), Gallagher Re and the Gallagher Research Center (GRC) revisited the 1923 Great Kantō earthquake to reflect on its 100-year anniversary. The catastrophic magnitude 7.9 megathrust tremor and resulting fires resulted in enormous economic costs that equaled 37% of Japan's then-GDP with extensive damage and loss of life. In total, the earthquake left more than 100,000 people dead (90% of the casualties attributed to fires) and damaged at least 370,000 homes.

For a more detailed look into the earthquake, including new research from IRIDS, please click here to download the Gallagher Research Centre white paper: The Great Wave.

# Appendix



# 2023 Events: Preliminary Statistics

Please note that the Appendix solely includes a listing of global events that resulted in ≥USD100 million in economic loss and/or ≥10 fatalities. It typically does not include a listing of aggregated loss totals from agencies that are not easily attributed to an individual event. Economic losses are provided in USD millions and are adjusted to year-to-date dollar values using the US Consumer Price Index, a construction index, and a cost of labor factor. Totals may be rounded and are subject to future development.

### Drought

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| China Drought | Jan. 1–Dec. 31 | Asia | CN | 2,815+ | - |
| India Drought | Jan. 1–Dec. 31 | Asia | IN | 2,565+ | - |
| Bali and East Papua Drought | Oct. 1-Dec. 31 | Asia | ID | - | 23 |
| France Drought | Jan. 1–Dec. 31 | Europe | FR | 410+ | - |
| Italy Drought | Jan. 1–Dec. 31 | Europe | IT | 770+ | - |
| Spain Drought | Jan. 1–Dec. 31 | Europe | ES | 8,200+ | - |
| Argentina Drought | Jan. 1–Dec. 31 | Latin America | AR | 9,200+ | - |
| Brazil Drought | Jan. 1–Dec. 31 | Latin America | BR | 7,200+ | - |
| Mexico Drought | Jan. 1–Dec. 31 | Latin America | MX | 2,400+ | - |
| Uruguay Drought | Jan. 1–Dec. 31 | Latin America | UY | 1,540+ | - |
| US Drought | Jan. 1–Dec. 31 | US | US | 14,900+ | - |

### Earthquake

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Marrakesh-Safi Earthquake | Sep. 8 | Africa | MA | 7,000+ | 2,960 |
| Jurm Earthquake | Mar. 21 | Asia | AF, PK | - | 21 |
| Herat Earthquake Sequence | Oct. 7–15 | Asia | AF | 50+ | 1,489 |
| Jajarkot Earthquake | Nov. 3 | Asia | NP | 20+ | 153 |
| Burais Earthquake | Nov. 17 | Asia | PH | 45+ | 11 |
| Jishishan Earthquake | Dec. 18 | Asia | CN | 2,000+ | 149 |
| Turkey Earthquake Sequence | Feb. 6–23 | Europe | TR, SY | 46,200+ | 59,259+ |
| Courcon France Earthquake | June. 16 | Europe | FR | 425+ | - |
| Guayas Earthquake | Mar. 19 | Latin America | EC, PE | Millions | 18 |
| Azerbaijan Earthquake | Jan. 28 | Middle East | IR | 255+ | 3 |

## European Windstorm

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Gerard/Gero | Jan. 15–18 | Europe | BE, CH, CZ, DE, FR, GB | 100+ | - |
| Otto/Ulf | Feb. 16–18 | Europe | DE, DK, GB, NO, SE, PL | 110+ | - |
| Larisa/Diethelm | Mar. 7–10 | Europe | AT, BE, CZ, DE, FR, IE, GB, NL, LU | 100+ | - |
| Mathis/Markus | Mar. 30–31 | Europe | BE, CH, CZ, DE, FR, GB | 150+ | 2 |
| Poly | Jul. 4–6 | Europe | DE, IT, NL | 320+ | 2 |
| Ciaran/Emir | Nov. 1–3 | Europe | BG, DE, ES, FR, GB, IE, IT, NL | 4,650+ | 21 |
| Domingos/Fred | Nov. 4–5 | Europe | ES, FR | 525+ | - |
| Frederico/Linus | Nov. 15–17 | Europe | DE, FR, GB | 110+ | 1 |
| Bettina and Oliver | Nov. 24–28 | Europe | BG, GR, MD, UA, RO, RU | Millions | 23 |
| Pia/Zoltan | Dec. 20–22 | Europe | AT, BE, CZ, DE, DK, FR, GB NL, NO | 590+ | 6 |
| Gerrit/Bodo | Dec. 26–28 | Europe | IE, GB | 140+ | 3 |

## Flooding/Landslides

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Southern Africa Floods | Feb. 4–14 | Africa | MZ, SW, ZA | 340+ | 29 |
| | Mar. 20–Apr. 1 | Africa | ET | – | 29 |
| Gu Rainy Season | Mar. 22–May 19 | Africa | SO | 25+ | 22 |
| | Mar. 23–27 | Africa | KE | – | 12 |
| Burundi Flooding | Mar. 30–Apr7 | Africa | BI | – | 14 |
| Angola April Floods | Apr. 1–28 | Africa | AO | – | 54 |
| | Apr. 23–27 | Africa | KE | – | 12 |
| East-Central Floods | May 2–9 | Africa | CD, RW, UG | 170+ | 629 |
| Niger Rain Season | Jul. 1–ep. 30 | Africa | NE | – | 41 |
| West Cape Floods | Sep. 23–26 | Africa | SA | 150+ | 11 |
| Nigeria October Floods | Oct. 5–20 | Africa | NG | – | 275 |
| | Oct. 8–9 | Africa | CM | – | 30 |
| East Africa Floods | Oct. 15–Dec. 11 | Africa | BI, ET, KE, MW, SO, TZ | Millions | 404+ |
| Central Congo Floods | Dec. 24–27 | Africa | CD | – | 62 |
| KwaZulu-Natal Floods | Dec. 25–29 | Africa | ZA | Millions | 31 |
| Philippines Flooding | Jan. 1–18 | Asia | PH | 30+ | 45 |
| | Jan. 25–Feb. 4 | Asia | ID | – | 15 |
| Serasan Landslide | Mar. 6 | Asia | ID | – | 50 |
| | Mar. 7–16 | Asia | ID | – | 16 |
| | Mar. 18–20 | Asia | PK | Millions | 10 |
| | Apr. 16 | Asia | IN | – | 13 |
| Torkham Landslide | Apr. 18 | Asia | PK | – | 12 |
| Southeast China Floods | May 2–7 | Asia | CN | 200+ | 4 |
| Shounter Pass Landslide | May 27 | Asia | PK | – | 11 |
| | Jun. 1–5 | Asia | CN | 105+ | 22 |
| | Jun. 7–10 | Asia | CN | 170+ | – |
| India Seasonal Floods | Jun. 14–Oct. 31 | Asia | IN | 5,015+ | 2,571 |
| China Seasonal Floods | Jun. 17–Sep. 30 | Asia | CN | 13,085+ | 302 |
| Pakistan Seasonal Floods | Jun. 22–Sep. 30 | Asia | PK | 10+ | 226 |

### Flooding/Landslides (continued)

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Japan July Heavy Rain | Jun. 29–Jul. 11 | Asia | JP | 1,340+ | 13 |
| | Jul. 2–6 | Asia | CN | – | 15 |
| | Jul. 9–18 | Asia | KR | 592+ | 47 |
| | Jul. 20 | Asia | BT | – | 23 |
| | Jul. 23–25 | Asia | AF | – | 38 |
| | Aug. 1–11 | Asia | BD | 25+ | 57 |
| Xi'an Mudslide | Aug. 8 | Asia | CN | – | 24 |
| Hpakant Jade Mine Disaster | Aug. 13 | Asia | MM | – | 33 |
| | Aug. 27–28 | Asia | TJ | – | 21 |
| Remnants of TY Haikui | Sep. 2–9 | Asia | CN, HK | 1,570+ | 14 |
| | Sep. 12 | Asia | VN | 10s of millions | 10 |
| Sikkim Flood — GLOF | Oct. 4–5 | Asia | IN | 95+ | 92+ |
| Yahukimo Landslide | Oct. 25–27 | Asia | ID | – | 17 |
| Tamil Nadu Flood | Dec. 18–20 | Asia | IN | 240+ | 35 |
| | Mar. 15 | Europe | TR | – | 18 |
| Halden Landslide | Apr. 27 | Europe | NO | 200+ | – |
| Italy Flood/Minerva | May 12–17 | Europe | BA, HE, IT | 9,700+ | 15 |
| Shovi Landslide | Aug. 3 | Europe | GE | – | 32 |
| Petar/Zacharias | Aug. 3–6 | Europe | AT, HR, SI | 3,067+ | 7 |
| Storm Hans | Aug. 6–8 | Europe | DK, DE, EE, FI, LV, LT, NO, SE | 965+ | 2 |
| September DANA Floods | Sep. 2–6 | Europe | ES, DZ | 250+ | 10 |
| Storm Daniel | Sep. 4–11 | Europe | BG, GR, LY, TR | 10,100+ | 4,361+ |
| Storm Elias | Sep. 25–27 | Europe | GR | 100+ | – |
| Babet and Aline | Oct. 17–21 | Europe | DE, DK, FR, GB, IE, NO | 1,530+ | 9 |
| Ecuador Rainy Season | Jan. 1–Mar. 12 | Latin America | EC | Millions | 25 |
| Peru Flooding H1 | Feb. 5–Jun. 13 | Latin America | PR | 100+ | 91 |
| Sao Paulo Floods | Feb. 18–20 | Latin America | BR | 30+ | 64 |
| Cyclone Yaku | Mar. 7–13 | Latin America | PE | 555+ | 8 |
| Alausi Landslide | Mar. 26 | Latin America | EC | Millions | 43 |
| Chimborazo Landslide | Apr. 26 | Latin America | EC | – | 23 |
| Guatemala Rainy Season | Jun. 1–Sep. 20 | Latin America | GT | 10s of millions | 35 |

### Flooding/Landslides (continued)

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Haiti June Floods | Jun. 3–5 | Latin America | HT | Millions | 58 |
| June Extratropical Cyclone | Jun. 15–19 | Latin America | BR | 200+ | 16 |
| Chile June Floods | Jun. 23–27 | Latin America | CL | 350+ | 2+ |
| | July 7–12 | Latin America | BR | Millions | 15 |
| | July 17–18 | Latin America | CO | Millions | 15 |
| Chile Atmospheric River | Aug. 17–22 | Latin America | CL | 1,650+ | 3 |
| Rio Grande do Sul Floods | Sep. 2–7 | Latin America | BR | 600+ | 49 |
| Santa Catarina Floods | Oct. 3–20 | Latin America | BR | 1,000+ | 6 |
| Southern Brazil Flood and SCS | Nov. 11–22 | Latin America | BR | 2,000+ | 8 |
| PTC22/Caribbean Floods | Nov. 16–19 | Latin America | CU, DO, HT, JM | 180+ | 32 |
| Bolivia Q4 Floods | Dec. 10–14 | Latin America | BO | – | 14 |
| Nova Scotia Flooding | Jul. 21–22 | North America | CA | 380+ | 4 |
| Ottawa Flooding | Aug. 10 | North America | CA | 175+ | – |
| North Island Floods | Jan. 26–Feb. 2 | Oceania | NZ | 3,050+ | 4 |
| CA Atmospheric River #1 | Jan. 4–10 | US | US | 1,425+ | 11 |
| CA Atmospheric River #2 | Jan. 11–16 | US | US | 610+ | 2 |
| CA Atmospheric River #3 | Jan. 17–19 | US | US | 145+ | – |
| Western US Upper-Level Low | Feb. 21–22 | US | US | 350+ | – |
| CA Atmospheric River #4 | Feb. 23–25 | US | US | 405+ | – |
| CA Atmospheric River #5 | Feb. 26–Mar. 2 | US | US | 215+ | – |
| CA Atmospheric River #6 | Mar. 9–12 | US | US | 252+ | 2 |
| CA Atmospheric River #7 | Mar. 13–15 | US | US | 605+ | 2 |
| CA Bomb Cyclone | Mar. 21–23 | US | US | 225+ | 5 |
| Ft. Lauderdale Flash Flood | Apr. 10–13 | US | US | 1,400+ | – |
| West Kentucky Floods | July 19 | US | US | 150+ | – |
| New York City Flash Flood | Sep. 28–29 | US | US | 1,100+ | – |
| Florida Non-Tropical Low | Nov. 14–17 | US | US | 400+ | – |
| December East Coast Low | Dec. 16–18 | US | US | 1,500+ | 6 |
| Southwest Upper Low | Dec. 18-24 | US | US | 180+ | – |

### Severe Convective Storm

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| | May 5–10 | Africa | SL | – | 15 |
| Johannesburg Hail | Nov. 13 | Africa | ZA | 100+ | 1 |
| | Mar. 16–20 | Asia | IN | Millions | 16 |
| | May 23–24 | Asia | BD | – | 18 |
| | May 26 | Asia | IN | Millions | 13 |
| | Jun. 9–11 | Asia | CN | 100+ | – |
| | Jun. 10–11 | Asia | PK | – | 27 |
| Gunma/Tokyo Hail | Jul. 31–Aug. 1 | Asia | JP | 710+ | – |
| Jiangsu Tornado and SCS | Sep. 19 | Asia | CN | 160+ | 10 |
| Gujarat Lightning Series | Nov. 26–27 | Asia | IN | – | 29 |
| Lows Kay and Lambert | June 18–23 | Europe | AT, BE, CZ, DE, FR, SK | 1,825+ | 1 |
| Zaragoza Flooding and SCS | Jul. 6 | Europe | ES, FR | 230+ | – |
| July SCS Outbreak #1 | Jul. 11–13 | Europe | AT, CZ, FR, DE, IT, RS, SI | 900+ | – |
| July SCS Outbreak #2 | Jul. 17–19 | Europe | AT, BA, HR, DE, IT, RS, SK, SI | 2,275+ | 6 |
| July SCS Outbreak #3 | Jul. 20–25 | Europe | BA, CH, DE, FR, HR, HU, IT, RO, RS, SK, SI | 3,715+ | 10 |
| | Jul. 30 | Europe | RU | Millions | 10 |
| Arend/Bernd | Aug. 12–16 | Europe | AT, CZ, DE, FR, IT, PO | 415+ | – |
| Denis/Rae | Aug. 24–30 | Europe | AT, CZ, FR, DE, IT, LT, LV, NO, PL, ES, CH | 2,410+ | – |
| Bahia Blanca SCS | Dec. 16 | Latin America | AR | 125+ | 15 |
| Canada Day SCS | Jul. 1 | North America | CA | 155+ | – |
| ON and QB Storms | Jul. 13 | North America | CA | 245+ | – |
| Calgary July Hail | Jul. 15–16 | North America | CA | 145+ | – |
| Southeast Canada SCS | Jul. 20–21 | North America | CA | 125+ | – |
| Early August Outbreak | Aug. 3 | North America | CA | 125+ | – |
| S. Ontario SCS and Flood | Aug. 23–25 | North America | CA | 160+ | – |
| Winnipeg Hail | Aug. 24 | North America | CA | 215+ | – |
| Newcastle Hailstorm | May 23–26 | Oceania | AU | 300+ | – |

### Severe Convective Storm (continued)

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Christmas SCS | Dec. 23–26 | Oceania | AU | 655+ | 10 |
| Selma Tornado and SCS | Jan. 12 | US | US | 840+ | 9 |
| Houston Tornado and SCS | Jan. 24 | US | US | 275+ | – |
| | Feb. 7 | US | US | 280+ | – |
| | Feb. 15–17 | US | US | 260+ | – |
| Southern Plains Derecho | Feb. 26–28 | US | US | 805+ | 1 |
| Early March SCS and Wind | Mar. 1–3 | US | US | 6,400+ | 13 |
| Dallas/Fort Worth Hail | Mar. 16–17 | US | US | 945+ | – |
| Mississippi Tornado and SCS | Mar. 23–28 | US | US | 2,825+ | 24 |
| Central US Outbreak | Mar. 30–Apri 1 | US | US | 6,100+ | 33 |
| Southern Plains Hail | Apr. 2 | US | US | 150+ | – |
| Early April US Outbreak | Apr. 3–5 | US | US | 2,910+ | 6 |
| Missouri Tornadoes and SCS | Apr. 14–16 | US | US | 1,380+ | – |
| Oklahoma Tornadoes and SCS | Apr. 18–22 | US | US | 3,260+ | 3 |
| Southern US Hail and SCS | Apr. 23–27 | US | US | 1,405+ | – |
| Late April Outbreak | Apr. 28–May 1 | US | US | 1,205+ | – |
| Early May Outbreak | May 2–9 | US | US | 2,485+ | 1 |
| Front Range + Midwest SCS | May 9–16 | US | US | 3,900+ | 1 |
| Texas Hail and SE SCS | May 17–20 | US | US | 1,790+ | – |
| | May 22–26 | US | US | 735+ | 2 |
| | May 23–25 | US | US | 150+ | – |
| | May 31–Jun. 4 | US | US | 220+ | – |
| | Jun. 5–8 | US | US | 590+ | – |
| Early June SCS Outbreak | Jun. 9–14 | US | US | 4,300+ | 4 |
| Mid-June SCS Outbreak | Jun. 15–19 | US | US | 3,965+ | – |
| Great Lakes June SCS | June 15–16 | US | US | 845+ | – |
| CO and TX Outbreak and SCS | Jun. 21–26 | US | US | 5,700+ | 7 |
| Midwest Derecho and SCS | Jun. 28–Jul. 4 | US | US | 2,105+ | – |
| | Jul. 3–9 | US | US | 795+ | – |
| Northeast SCS and Floods | Jul. 5–10 | US | US | 2,020+ | 10 |
| IL Tornadoes and Central SCS | July 9–14 | US | US | 1,665+ | – |
| Mid-July SCS and NC Tornado | Jul. 15–19 | US | US | 990+ | – |
| MN Hail and Eastern SCS | July 19–21 | US | US | 1,920+ | 1 |
| Colorado July Outbreak | July 19–20 | US | US | 250+ | – |
| Central and Eastern Outbreaks | July 25–31 | US | US | 1,565+ | – |

### Severe Convective Storm (continued)

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Arizona Dust Storm and SCS | July 25–30 | US | US | 155+ | – |
| August Extended Outbreak | Aug. 4–8 | US | US | 1,740+ | 2 |
| Minneapolis Hail | Aug. 10–11 | US | US | 2,050+ | – |
| Mid-August Outbreak | Aug. 12–15 | US | US | 345+ | 1 |
| Great Lakes SCS | Aug. 22–24 | US | US | 1,100+ | 5 |
| Phoenix SCS and Floods | Aug. 31–Sep. 2 | US | US | 215+ | – |
| Eastern SCS and Floods | Sep. 9–11 | US | US | 835+ | – |
| | Sep. 12–14 | US | US | 200+ | – |
| Southern Plains Hail | Sep. 23–24 | US | US | 1,800+ | – |
| | Sep. 26–27 | US | US | 360+ | 2 |
| | Oct. 2–5 | US | US | 590+ | – |
| Upper Midwest Storms | Oct. 23–24 | US | US | 290+ | – |
| Texas SCS and Floods | Oct. 24–26 | US | US | 275+ | 2 |
| Mid-South December SCS | Dec. 8–10 | US | US | 800+ | 6 |

## Tropical Cyclone

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Tropical Storm Cheneso | Jan. 18–25 | Africa | MG | 20+ | 25 |
| Cyclone Freddy | Feb. 21–Mar. 5 | Africa | MG, MU, MW, MZ, ZW | 900+ | 1,434 |
| Cyclone Mocha | May 13–15 | Asia | MM, BD, IN | 2,240+ | 463 |
| Typhoon Mawar | May 23–Jun. 2 | Asia | GU, PH, TW, JP | 700+ | 9 |
| Cyclone Biparjoy | Jun. 15–17 | Asia | PK, IN | 250+ | 16 |
| Typhoon Talim | Jul. 17–18 | Asia | PH, HK, CN | 370+ | 2 |
| Typhoon Doksuri | Jul. 24–31 | Asia | PH, TW, CN | 18,460+ | 111 |
| Typhoon Khanun | Aug. 2–11 | Asia | JP, TW, KR, RU | 455+ | 10 |
| Typhoon Lan | Aug. 14–16 | Asia | JP | 565+ | – |
| Typhoon Saola | Aug. 27–Sep. 2 | Asia | PH, CN, HK | 635+ | 2 |
| Typhoon Haikui | Sep. 2–8 | Asia | CN, TW | 1,680+ | – |
| Tropical Storm Yun-yeung | Sep. 8–9 | Asia | JP | 300+ | 3 |
| Tropical Storm Sanba | Oct. 19–20 | Asia | CN | 810+ | 4 |
| Cyclone Michaung | Dec. 4–6 | Asia | IN | 1,900+ | 17 |
| Hurricane Lidia | Oct. 10–12 | Latin America | MX | 100+ | 2 |
| Hurricane Otis | Oct. 24–26 | Latin America | MX | 15,100+ | 52 |
| Tropical Storm Pilar | Oct. 31–Nov. 2 | Latin America | GT, HN, NI, SV | 50+ | 11 |
| Hurricane Lee | Sep. 15–17 | North America | CA, US | 140+ | 2 |
| Cyclone Gabrielle | Feb. 11–17 | Oceania | NZ | 3,770+ | 11 |
| Cyclone Jasper | Dec. 5–17 | Oceania | SB, AU | 755+ | 1 |
| Hurricane Hilary | Aug. 19–22 | US | MX, US | 1,050+ | 2 |
| Hurricane Idalia | Aug. 29–31 | US | CU, US | 3,520+ | 2 |
| Tropical Storm Ophelia | Sep. 23–26 | US | US | 380+ | 2 |

## Wildfire

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| | Jul. 23–26 | Africa | GZ | – | 34 |
| Kazakhstan Wildfires | Jun. 8–15 | Asia | KZ | – | 15 |
| Asturias Spring Wildfires | Mar. 20–Apr. 13 | Europe | ES | 160+ | – |
| Kurgan Region Wildfires | May 6–11 | Europe | RU | – | 21 |
| Spain Q3 Wildfires | Jul. 1–Sep. 1 | Europe | ES | 700+ | – |
| Greece Summer Wildfires | Jul. 13–Sep. 1 | Europe | GR | 1,700+ | 23 |
| Chile Wildfires | Jan. 30–Feb. 18 | Latin America | CL | 500+ | 26 |
| Bolivia Wildfires | Nov. 17–30 | Latin America | BO | – | 12 |
| Tantallon Fire | May 28–Jun. 4 | North America | CA | 280+ | – |
| Hay River Fire | Aug. 13–16 | North America | CA | 100+ | – |
| Kelowna Area Wildfires | Aug. 15–Sep. 21 | North America | CA | 750+ | – |
| Bush Creek East Fire | Aug. 18–Sep. 1 | North America | CA | 415+ | – |
| Lahaina Fire | Aug. 8–10 | US | US | 6,000+ | 97 |
| Gray Fire | Aug. 18–24 | US | US | 700+ | 1 |

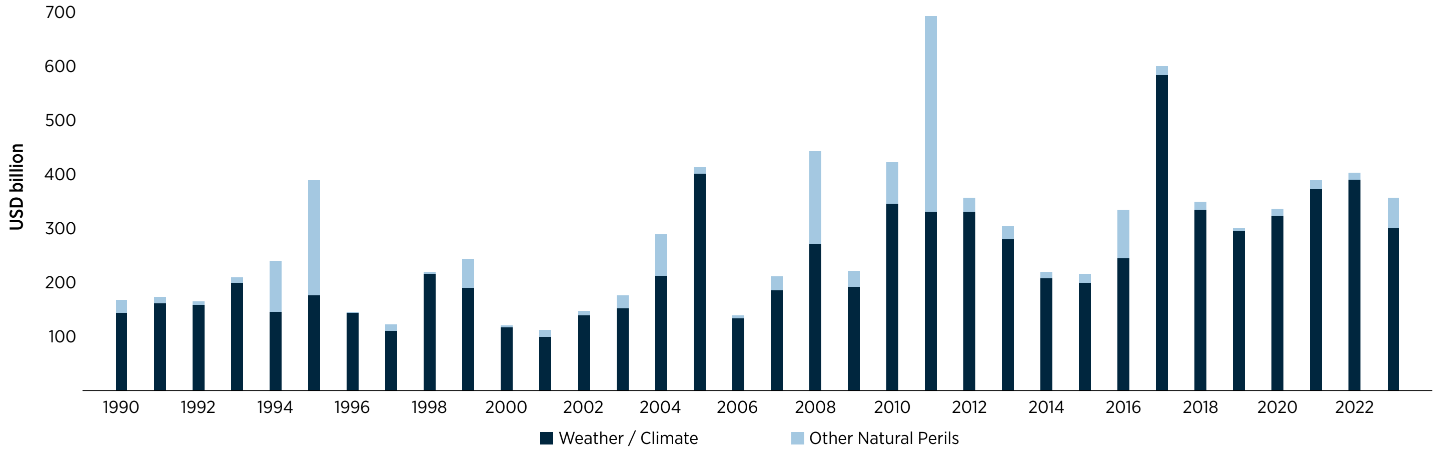
## Winter Weather

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| North India Cold Wave | Jan. 5–17 | Asia | IN | Millions | 25 |
| Afghanistan Cold Spell | Jan. 10–27 | Asia | AF | – | 166 |
| Nyingchi Avalanche | Jan. 17 | Asia | CN | – | 28 |
| Tajik Avalanche | Feb. 15–16 | Asia | TJ | Millions | 20 |
| | Apr. 20–24 | Asia | CN | 190+ | 1 |
| | Feb. 4–5 | Europe | AT, IT, CH | – | 11 |
| December Winter Blast | Dec. 2–3 | Europe | AT, CH, CZ, DE | 100+ | 2 |
| Eastern Canada Freeze | Feb. 3–5 | North America | CA | 175+ | – |
| Canada Spring Ice Storm | April 5–6 | North America | CA | 450+ | – |
| Southern Plains Ice Storm | Jan. 30–Feb. 2 | United States | US | 355+ | 10 |
| Northeast Freeze | Feb. 2–5 | United States | US | 2,015+ | 1 |
| Upper Midwest Blizzard | Feb. 21–23 | United States | US | 265+ | 3 |
| March Nor’easter | Mar. 13–15 | United States | US | 215+ | – |

### Other

| Event Name | Date | Region | Countries | Economic Loss (USD) | Fatalities |
|---|---|---|---|---|---|
| Bangladesh Heatwave | Apr. 1–Jun. 7 | Asia | BD | – | 20+ |
| Japan Seasonal Heatwave | May 1–Sep. 30 | Asia | JP | – | 106 |
| South Korea Heatwave | Jun. 16–30 | Asia | KR | – | 32 |
| India June Heatwave | Jun. 17–19 | Asia | IN | – | 264+ |
| Pakistan June Heatwave | Jun. 23–26 | Asia | PK | – | 22 |
| Marapi Volcano Eruption | Dec. 3 | Asia | ID | – | 23 |
| Europe June Heatwave | Jun. 1–30 | Europe | – | – | 3,500+ |
| Europe July Heatwave | Jul. 1–31 | Europe | – | – | 3,900+ |
| Europe August Heatwave | Aug. 1–30 | Europe | – | – | 8,000+ |
| Mexico Heatwaves | Mar. 19–Sep. 30 | North America | MX | – | 421+ |
| US Summer Heatwaves | Jun. 1–Aug. 30 | US | US | – | 618+ |

# Historical Annual Natural Catastrophe Economic Losses: 1990–2023




| | Weather / Climate | Other Natural Perils | Grand Total |
|---|---|---|---|
| 1990 | 144 | 23 | 168 |
| 1991 | 161 | 11 | 172 |
| 1992 | 158 | 6 | 164 |
| 1993 | 200 | 9 | 209 |
| 1994 | 145 | 95 | 240 |
| 1995 | 176 | 212 | 388 |
| 1996 | 144 | 2 | 146 |
| 1997 | 110 | 12 | 122 |
| 1998 | 216 | 3 | 219 |
| 1999 | 190 | 52 | 243 |
| 2000 | 117 | 3 | 120 |
| 2001 | 98 | 14 | 112 |
| 2002 | 139 | 7 | 146 |
| 2003 | 152 | 24 | 176 |
| 2004 | 213 | 77 | 290 |
| 2005 | 401 | 12 | 413 |
| 2006 | 134 | 6 | 139 |

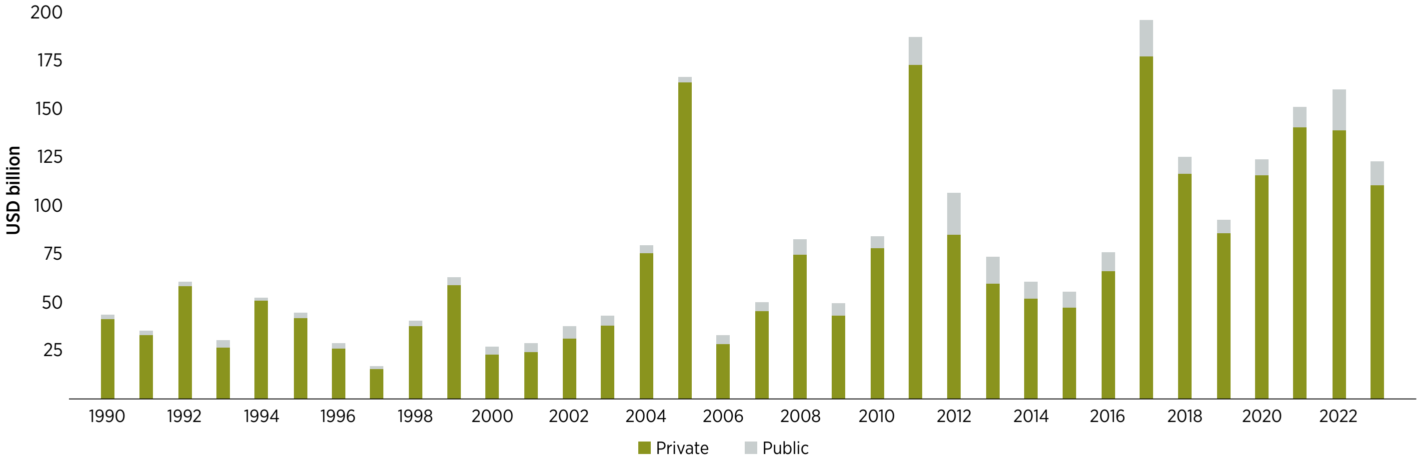
| | Weather / Climate | Other Natural Perils | Grand Total |
|---|---|---|---|
| 2007 | 186 | 24 | 210 |
| 2008 | 272 | 172 | 444 |
| 2009 | 192 | 29 | 221 |
| 2010 | 345 | 78 | 423 |
| 2011 | 331 | 362 | 692 |
| 2012 | 331 | 25 | 356 |
| 2013 | 280 | 24 | 303 |
| 2014 | 207 | 12 | 219 |
| 2015 | 200 | 16 | 216 |
| 2016 | 244 | 91 | 335 |
| 2017 | 584 | 15 | 599 |
| 2018 | 334 | 14 | 349 |
| 2019 | 296 | 5 | 300 |
| 2020 | 322 | 13 | 335 |
| 2021 | 372 | 17 | 389 |
| 2022 | 390 | 14 | 404 |
| 2023 | 301 | 57 | 357 |

| | Weather / Climate | Other Natural Perils | Grand Total |
|---|---|---|---|
| Avg (Decadal) | 323 | 22 | 345 |
| Avg (21st Century) | 267 | 46 | 313 |
| Median (Decadal) | 309 | 26 | 335 |
| Median (21st Century) | 272 | 31 | 303 |

| Annual Rates of Growth | |
|---|---|
| All Perils Economic (1990-) | +2.8% |
| All Perils Economic (2000-) | +4.1% |
| All Perils Economic (Decadal) | +4.7% |
| Wx / Climate Economic (1990-) | +3.2% |
| Wx / Climate Economic (2000-) | +4.5% |
| Wx / Climate Economic (Decadal) | +5.1% |

**Figure 40:** Annual historical natural catastrophe economic losses in 2023 USD. Note: Some totals may be rounded. | **Data and Graphic:** Gallagher Re

# Historical Annual Natural Catastrophe Insured Losses: 1990–2023




| | Private Market | Public Entity | Grand Total |
|---|---|---|---|
| 1990 | 41 | 2 | 44 |
| 1991 | 33 | 2 | 35 |
| 1992 | 58 | 2 | 60 |
| 1993 | 27 | 3 | 30 |
| 1994 | 51 | 1 | 52 |
| 1995 | 42 | 3 | 44 |
| 1996 | 26 | 3 | 29 |
| 1997 | 15 | 2 | 17 |
| 1998 | 37 | 3 | 40 |
| 1999 | 59 | 4 | 63 |
| 2000 | 23 | 4 | 27 |
| 2001 | 24 | 5 | 29 |
| 2002 | 31 | 7 | 38 |
| 2003 | 38 | 5 | 43 |
| 2004 | 75 | 4 | 79 |
| 2005 | 164 | 3 | 166 |
| 2006 | 29 | 5 | 33 |

| | Private Market | Public Entity | Grand Total |
|---|---|---|---|
| 2007 | 45 | 5 | 50 |
| 2008 | 75 | 8 | 83 |
| 2009 | 43 | 6 | 49 |
| 2010 | 78 | 6 | 84 |
| 2011 | 173 | 14 | 187 |
| 2012 | 85 | 21 | 106 |
| 2013 | 60 | 14 | 73 |
| 2014 | 52 | 9 | 61 |
| 2015 | 47 | 8 | 56 |
| 2016 | 66 | 10 | 76 |
| 2017 | 177 | 19 | 196 |
| 2018 | 117 | 9 | 125 |
| 2019 | 86 | 7 | 93 |
| 2020 | 116 | 8 | 124 |
| 2021 | 140 | 10 | 151 |
| 2022 | 139 | 21 | 160 |
| 2023 | 110 | 13 | 123 |

| | Private Market | Public Entity | Grand Total |
|---|---|---|---|
| Avg (Decadal) | 100 | 11 | 111 |
| Avg (21st Century) | 82 | 9 | 91 |
| Median (Decadal) | 101 | 9 | 108 |
| Median (21st Century) | 75 | 8 | 79 |

| Annual Rates of Growth | |
|---|---|
| All Perils Insured (1990-) | +4.7% |
| All Perils Insured (2000-) | +6.0% |
| All Perils Insured (Decadal) | +9.9% |
| Wx / Climate Insured (1990-) | +5.2% |
| Wx / Climate Insured (2000-) | +6.0% |
| Wx / Climate Insured (Decadal) | +10.1% |

**Figure 41:** Annual historical natural catastrophe insured losses in 2023 USD. Note: Some totals may be rounded. | **Data and Graphic:** Gallagher Re

# Total Number of Billion-Dollar Events: Economic and Insured (1990–2023)

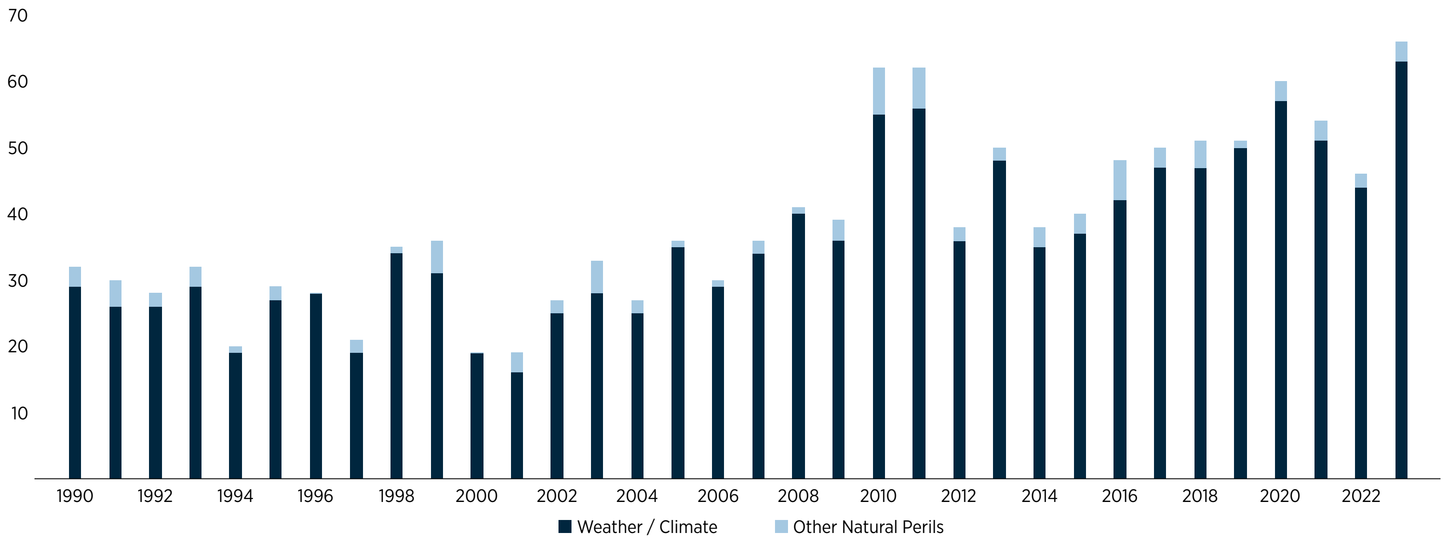



**Figure 42:** Total number of billion-dollar economic loss natural catastrophes; losses adjusted to 2023 USD | **Data and Graphic:** Gallagher Re

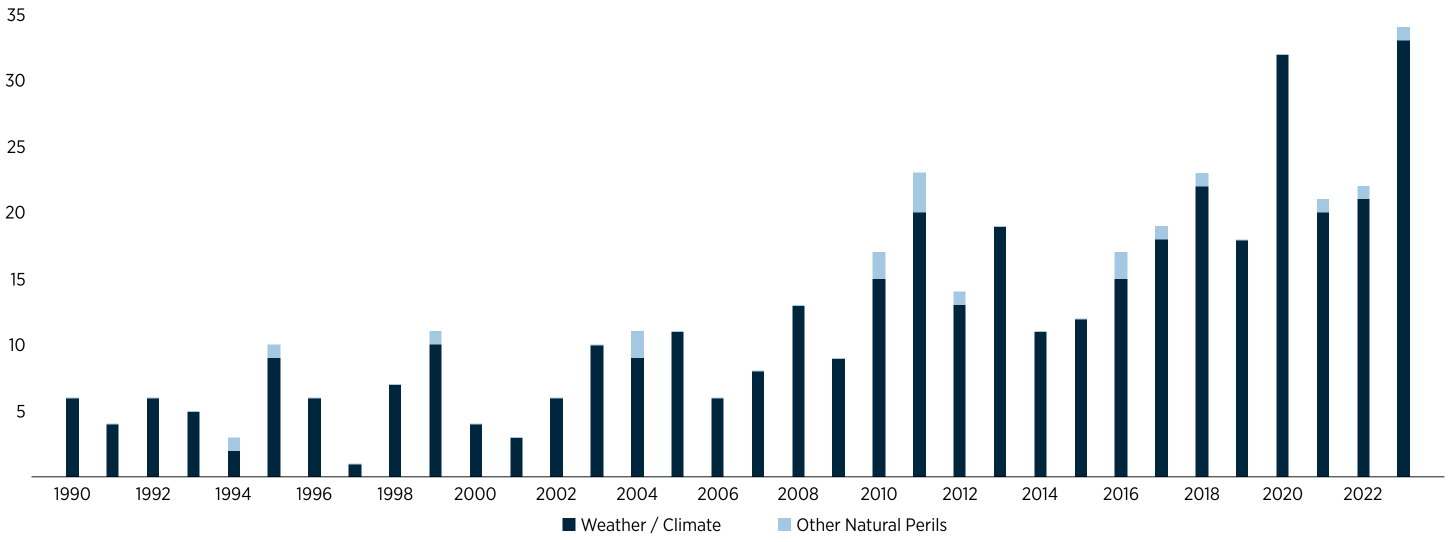



**Figure 43:** Total number of billion-dollar insured loss natural catastrophes; losses adjusted to 2023 USD | **Data and Graphic:** Gallagher Re

## Country Abbreviations

| Country Name | Abbreviation |
|---|---|
| Afghanistan | AF |
| Aland Islands | AX |
| Albania | AL |
| Algeria | DZ |
| American Samoa | AS |
| Andorra | AD |
| Angola | AO |
| Anguilla | AI |
| Antarctica | AQ |
| Antigua and Barbuda | AG |
| Argentina | AR |
| Armenia | AM |
| Aruba | AW |
| Australia | AU |
| Austria | AT |
| Azerbaijan | AZ |
| Bahamas | BS |
| Bahrain | BH |
| Bangladesh | BD |
| Barbados | BB |
| Belarus | BY |
| Belgium | BE |
| Belize | BZ |
| Benin | BJ |
| Bermuda | BM |
| Bhutan | BT |
| Bolivia | BO |
| Bonaire, Saint Eustatius and Saba | BQ |
| Bosnia and Herzegovina | BA |
| Botswana | BW |
| Bouvet Island | BV |
| Brazil | BR |
| British Indian Ocean Territory | IO |
| Virgin Islands (UK) | VG |
| Brunei | BN |
| Bulgaria | BG |
| Burkina Faso | BF |
| Burundi | BI |
| Cambodia | KH |
| Cameroon | CM |
| Canada | CA |
| Cape Verde | CV |
| Cayman Islands | KY |

| Country Name | Abbreviation |
|---|---|
| Central African Republic | CF |
| Chad | TD |
| Chile | CL |
| China | CN |
| Christmas Island | CX |
| Cocos Islands | CC |
| Colombia | CO |
| Comoros | KM |
| Cook Islands | CK |
| Costa Rica | CR |
| Croatia | HR |
| Cuba | CU |
| Curacao | CW |
| Cyprus | CY |
| Czech Republic | CZ |
| Democratic Republic of the Congo | CD |
| Denmark | DK |
| Djibouti | DJ |
| Dominica | DM |
| Dominican Republic | DO |
| East Timor | TL |
| Ecuador | EC |
| Egypt | EG |
| El Salvador | SV |
| Equatorial Guinea | GQ |
| Eritrea | ER |
| Estonia | EE |
| Ethiopia | ET |
| Falkland Islands | FK |
| Faroe Islands | FO |
| Fiji | FJ |
| Finland | FI |
| France | FR |
| French Guiana | GF |
| French Polynesia | PF |
| French Southern Territories | TF |
| Gabon | GA |
| Gambia | GM |
| Georgia | GE |
| Germany | DE |
| Ghana | GH |
| Gibraltar | GI |
| Greece | GR |

| Country Name | Abbreviation |
|---|---|
| Greenland | GL |
| Grenada | GD |
| Guadeloupe | GP |
| Guam | GU |
| Guatemala | GT |
| Guernsey | GG |
| Guinea | GN |
| Guinea-Bissau | GW |
| Guyana | GY |
| Haiti | HT |
| Heard Island and McDonald Islands | HM |
| Honduras | HN |
| Hong Kong | HK |
| Hungary | HU |
| Iceland | IS |
| India | IN |
| Indonesia | ID |
| Iran | IR |
| Iraq | IQ |
| Ireland | IE |
| Isle of Man | IM |
| Israel | IL |
| Italy | IT |
| Ivory Coast | CI |
| Jamaica | JM |
| Japan | JP |
| Jersey | JE |
| Jordan | JO |
| Kazakhstan | KZ |
| Kenya | KE |
| Kiribati | KI |
| Kosovo | XK |
| Kuwait | KW |
| Kyrgyzstan | KG |
| Laos | LA |
| Latvia | LV |
| Lebanon | LB |
| Lesotho | LS |
| Liberia | LR |
| Libya | LY |
| Liechtenstein | LI |
| Lithuania | LT |
| Luxembourg | LU |

## Country Abbreviations

| Country Name | Abbreviation |
|---|---|
| Macao | MO |
| Macedonia | MK |
| Madagascar | MG |
| Malawi | MW |
| Macedonia | MK |
| Malaysia | MY |
| Maldives | MV |
| Mali | ML |
| Malta | MT |
| Marshall Islands | MH |
| Martinique | MQ |
| Mauritania | MR |
| Mauritius | MU |
| Mayotte | YT |
| Mexico | MX |
| Micronesia | FM |
| Moldova | MD |
| Monaco | MC |
| Mongolia | MN |
| Montenegro | ME |
| Montserrat | MS |
| Morocco | MA |
| Mozambique | MZ |
| Myanmar | MM |
| Namibia | NA |
| Nauru | NR |
| Nepal | NP |
| Netherlands | NL |
| Netherlands Antilles | AN |
| New Caledonia | NC |
| New Zealand | NZ |
| Nicaragua | NI |
| Niger | NE |
| Nigeria | NG |
| Niue | NU |
| Norfolk Island | NF |
| North Korea | KP |
| Northern Mariana Islands | MP |
| Norway | NO |
| Oman | OM |
| Pakistan | PK |
| Palau | PW |
| Palestinian Territory | PS |

| Country Name | Abbreviation |
|---|---|
| Panama | PA |
| Papua New Guinea | PG |
| Paraguay | PY |
| Peru | PE |
| Philippines | PH |
| Pitcairn | PN |
| Poland | PL |
| Portugal | PT |
| Puerto Rico | PR |
| Qatar | QA |
| Republic of the Congo | CG |
| Reunion | RE |
| Romania | RO |
| Russia | RU |
| Saint Kitts and Nevis | KN |
| Saint Lucia | LC |
| Saint Martin | MF |
| Saint Pierre and Miquelon | PM |
| Saint Vincent & The Grenadines | VC |
| Samoa | WS |
| San Marino | SM |
| Sao Tome and Principe | ST |
| Saudi Arabia | SA |
| Senegal | SN |
| Serbia | RS |
| Serbia and Montenegro | CS |
| Seychelles | SC |
| Sierra Leone | SL |
| Singapore | SG |
| Sint Maarten | SX |
| Slovakia | SK |
| Slovenia | SI |
| Solomon Islands | SB |
| Somalia | SO |
| South Africa | ZA |
| South Georgia and the South Sandwich Islands | GS |
| South Korea | KR |
| South Sudan | SS |
| Spain | ES |
| Sri Lanka | LK |
| Sudan | SD |
| Suriname | SR |
| Svalbard and Jan Mayen | SJ |

| Country Name | Abbreviation |
|---|---|
| Swaziland | SZ |
| Sweden | SE |
| Switzerland | CH |
| Syria | SY |
| Taiwan | TW |
| Tajikistan | TJ |
| Tanzania | TZ |
| Thailand | TH |
| Togo | TG |
| Tokelau | TK |
| Tonga | TO |
| Trinidad and Tobago | TT |
| Tunisia | TN |
| Turkey | TR |
| Turkmenistan | TM |
| Turks and Caicos Islands | TC |
| Tuvalu | TV |
| Virgin Islands (U.S.) | VI |
| Uganda | UG |
| Ukraine | UA |
| United Arab Emirates | AE |
| United Kingdom | GB |
| United States | US |
| Uruguay | UY |
| Uzbekistan | UZ |
| Vanuatu | VU |
| Vatican | VA |
| Venezuela | VE |
| Vietnam | VN |
| Wallis and Futuna | WF |
| Western Sahara | EH |
| Yemen | YE |
| Zambia | ZM |
| Zimbabwe | ZW |

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