Gallagher Re

JANUARY 2025

Natural Catastrophe and Climate Report: 2024

Data, Insights, and Perspectives

Foreword

Welcome to Gallagher Re's 2024 Natural Catastrophe and Climate Report. This document summarizes the most notable events and topics of conversation from the previous calendar year.

In 2024, the estimated total direct economic costs from global natural perils were USD417 billion. The private insurance market and public insurance entities covered USD154 billion of that total. The annual average loss from natural catastrophes from 2017 to 2024 has cost insurers USD146 billion. This suggests a 'new normal' approaching USD150 billion per year.

With each year we continue to witness an increase in the severity and high-impact frequency of natural catastrophe events in expected, and increasingly unexpected, parts of the world. While the (re)insurance industry remains in strong position to withstand these higher aggregated loss costs, we face a new growing reality. The complex challenges arising from these events is accelerating the need to better identify how physical and non-physical risk profiles are evolving. We must also recognize the various ways these risks are increasingly linked together.

In this report, we aim to help readers give greater thought to how topics such as climate change, specific individual peril loss drivers, 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 others.

The report also features unique insights from colleagues across the Gallagher family and some of our academic partners via the Gallagher Research Centre. This outside expertise helps us better inform our clients and other key private and public sector stakeholders on various natural catastrophe, climate change, sustainability, and regulatory topics.

Readers of this report can expect to:

- Explore global and regional catastrophe peril and loss drivers
- Learn about emerging hazard or loss trends at a global or regional level to better prepare for tomorrow's risks
- Identify the role of climate change and how it continues to influence decision making by the (re)insurance industry
- Better understand how climate risk management is taking on greater importance for global regulators and the insurance industry to better assess scenarios for financial stakeholders

At Gallagher Re, we provide dedicated analytical, product, and practice support to help our clients develop strategies to better assess risks linked with natural hazards, climate change, and sustainability topics. We offer unique partnerships through the Gallagher Research Centre, the Public Sector, Parametric & Climate Resilience Solutions group, and our Green Solutions team. We recognize that there is tremendous value in blending physical risk solutions with emerging transition risk solutions (carbon markets, alternative energy, adaptation financing, etc.) as we collectively work to meet 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 2025.

Steve Bowen
Chief Science Officer
Gallagher Re

Executive Summary

Executive Summary

- Global insured losses at USD154 billion; 27% above the recent 10-year average (2014-2023) of USD121 billion
- Several examples of significant insured loss events in non-traditional insurance markets in 2024, highlighting risk growth
- NOAA and most other global weather / climate agencies declared 2024 as the warmest year on record

2024 was a year marked by major natural catastrophe events in the developed world, but also several impactful events in non-traditional insurance markets. The year was enhanced by the lingering effects of a strong El Niño phase of the El Niño-Southern Oscillation (ENSO), before those conditions dissipated and a weak La Niña-like conditions began. The estimated direct economic cost of natural hazards was USD417 billion. The private insurance market and public insurance entities covered an estimated USD154 billion of that total. This meant that the portion of event costs not covered by insurance — known as the protection gap — stood at 63%, or USD263 billion. There was a minimum of 60 individual billion-dollar economic loss events. At least 30 of those were also billion-dollar insured loss events.

The economic cost solely from weather and climate events in 2024, which excludes losses from earthquakes or other non-atmospheric-driven events, was an estimated USD402 billion, of which insurers covered an estimated USD151 billion. A record 21 events resulted in a multi-billion-dollar cost for the insurance industry: topping the previous record of 17 set in 2023 and 2020. At least 41% of insured losses (USD64 billion) resulted from the severe convective storm (SCS) peril. SCS events in 2023 and 2024 have now cost global insurers a remarkable USD143 billion, of which USD120 billion occurred in the US alone. The costliest global events for insurers were Hurricane Helene and Hurricane Milton; each cost USD20 billion.

While 2024 was not a record year for total loss costs, we are continuing to witness the ongoing influence of climate change on the behavior of individual events and broader weather patterns. 2024 officially became the warmest year on record dating to 1850, and scientists believe it was the warmest year in the last 125,000 years. Scientific research is concluding that there are differences in what a climate change influence looks like on an individual peril basis and how certain parts of the world will be affected. The fingerprints of climate risk do undeniably exist on many individual events. One must understand that climate risk is not solely an issue for physical damage potential, however, and the non-physical implications are substantial. This may affect sectors such as real estate, agriculture, industry and manufacturing; as well as impacting health and retirement, and the long-term strategies of investors.

The reduction of greenhouse gas emissions is essential to this process, and this will be vital in stabilizing or reducing the impact of future extreme weather events. The insurance industry maintains a critical role in addressing and working to mitigate climate risk, but it must be done collectively with other private and public market stakeholders. For (re)insurers, annual loss volatility with some climate risk influence will play a key role in future premium costs. Gallagher Re's 2025 1st View Report noted that given 2024 resulted in manageable natural catastrophe market losses, the January 1 renewal cycle brought rational pricing to property placements.

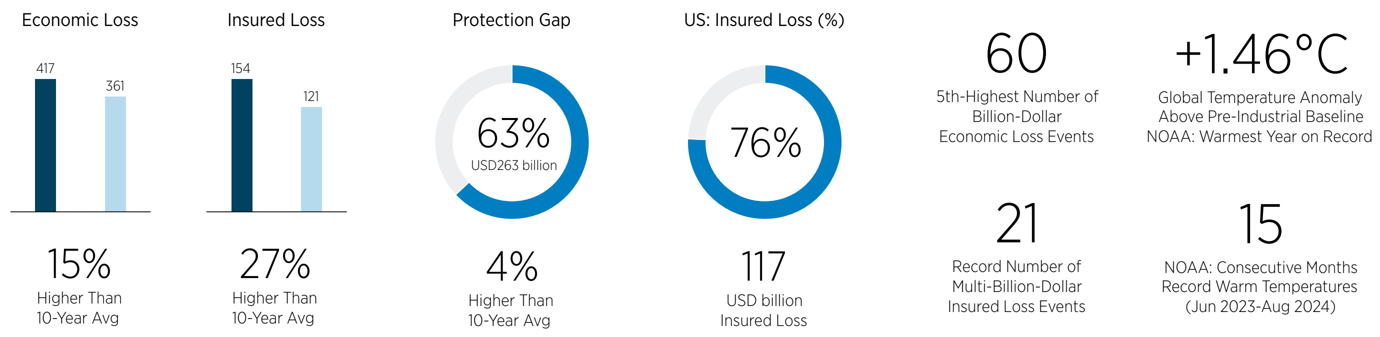

Figure 1: Executive summary highlighting key 2024 takeaways | **Temperature Data:** NOAA | **Loss Data & Graphic:** Gallagher Re

Newsworthy Topics

Interpreting the Science: Intriguing Takeaways and Emerging Areas of Focus

Compound risk: Are we connecting the dots?

The implications of extreme weather and climate change are often viewed through the singular lens of physical damage. The reality, however, is that while physical damage is often the initial focus, the societal implications are increasingly felt well beyond the location of a specific event. Such a scenario showcases the cascading effect of these occurrences. These non-physical impacts highlight the complex combinations of societal drivers which can exacerbate feedback loops often referred to as compound risk.

The simple definition of compound risk is when two or more factors (physical or non-physical hazards) directly interact to increase the overall severity of risk. Another way of describing such a process is the phrase "connected extremes." Such scenarios can quickly identify soft spots in enterprise risk management strategies, lapses in governance, areas of improvement in disaster preparedness, and limitations in effective communication. As the financial and humanitarian costs of climate change continue to increase, having a clearer understanding of how to better link climatic and societal drivers needs to become standard practice in forming a complete view of risk. Some important tools for this can be found in climate ensemble modeling; scenario-based catastrophe or hazard modeling; integrated non-physical hazard assessment models; stress testing; or other multivariate analysis modeling. A 2020 research paper explored this topic in depth.

It should be noted that there are also increasing correlations of risk between individual weather perils. The amplification of climate change influence on weather patterns can result in the rapid shift from one peril impact to another. Such a phenomenon is known as "weather whiplash." This is now a regular occurrence that warrants further investigation from an underwriting perspective. Meteorological forecast agencies are also more frequently linking together various peril risks.

The flowchart in **Figure 2** illustrates how the concept of compound risk and connected extremes work. Let's use a tropical cyclone landfall as a real-world example. Once the storm strikes, it causes immediate wind and water-related physical damage. First, we learn whether the building stock or infrastructure was able to withstand the hazard impacts. Weak spots in local building codes, emergency evacuation planning, or electrical grids may be revealed. In the hours and days afterwards, the non-direct implications can become more prevalent. The humanitarian impact can strain health systems. Damaged infrastructure or electrical grids can lead to regional or global disruption to manufacturing and supply chains. Such affects may depress economic growth in communities. Further, repeated disasters in a particular region may lead to depreciation of home values, putting a strain on the housing market and leading to a surplus of unsold properties. This scenario could be exacerbated by a reassessment of risk and changes to insurance costs. In some places, these factors additionally cause changes to retirement location trends and investment strategies of pension funds.

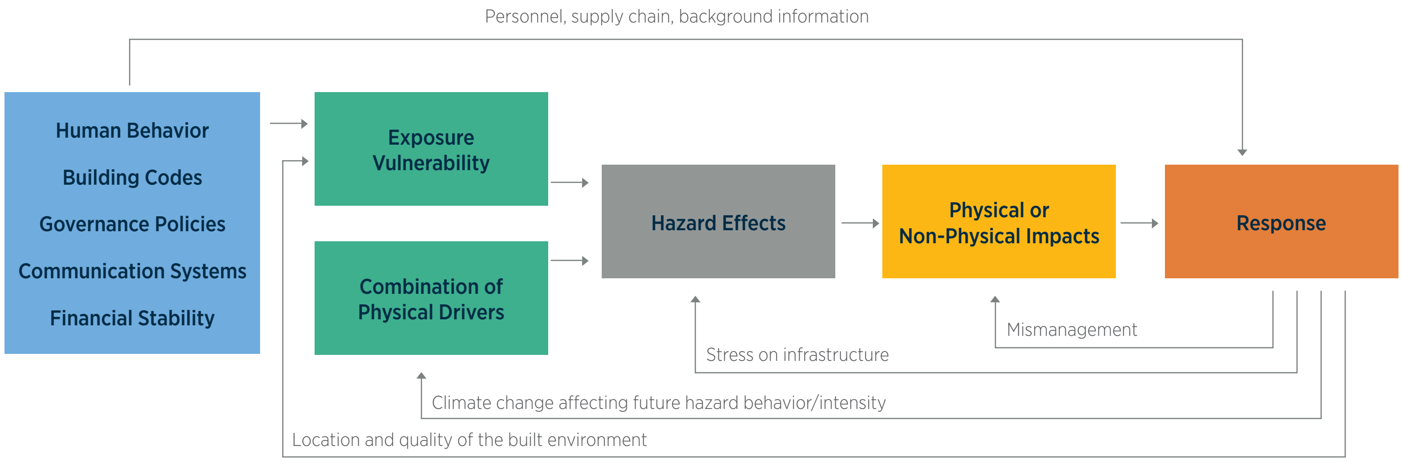

Figure 2: Flowchart highlighting compound risk / connected extremes | **Source:** Adapted from Raymond, et al (2020)

These are just some of the broader factors to consider. The bottom line is while weather and climate events are often described and treated as individual occurrences, the linked and cascading effects can be enormously consequential if not strategically addressed. For example, there can be a knock-on effect on social inequality. The compound nature of these increasingly impactful events is only further extending the divide between those with the financial means to absorb societal disruption, and those without.

This is where the insurance industry can be further used for good. The integration of public and private sector alliances to provide ample financing in both proactive and reactive timeframes can considerably improve our ability to withstand more financial or humanitarian shocks from these events. The foundational premise of insurance is to help people in their time of need. But the insurance industry cannot solve these issues in isolation. It must work with the financial sector, government, academia, and others to collaboratively address how to properly assess risk and provide the financial support to ensure equitable protection and adaptation in both developed and emerging regions of the world.

AI models improve weather forecasting

The growing societal impacts from weather and climate events become more obvious by the day. As risk accelerates, the need for more comprehensive and accurate forecasting models becomes more critical. For the insurance industry, there is heavy reliance on numerical weather prediction models to precisely understand the short-term and real-time impacts from individual small- or large-scale events that may affect clients. Better and more high-resolution data is vital in communicating hazard risk but is also used to deploy insurance assessors to more quickly help people in the immediate aftermath of an event. Any improvement in our ability to forecast with more precision at a lead time of several days, or possibly a week, would be a tremendous step forward in risk management.

In recent years, there has been major investment and implementation of artificial intelligence (AI) technologies by public and private sector entities. This has resulted in better accuracy within the weather forecasting enterprise that the insurance industry closely monitors. In early 2024, the European Centre for Medium-Range Weather Forecasts (ECMWF) announced that it was moving forward on a hybrid model to combine conventional and machine learning methodologies that would conclude with a fully data-driven forecasting system. This complex initiative, known as the Artificial Intelligence/Integrated Forecasting System (AIFS), was already showcasing improved skill compared to its older generation modeling technology known as the Integrated Forecast System (IFS).

Some of the most intriguing improvements in this space have come in the private sector. Google, for example, has been quite active. The latest generation model from its DeepMind initiative, known as GenCast, provides up to 15-day forecasts with impressive skill. In fact, Google recently announced that GenCast had outperformed the ECMWF's IFS-based ensemble forecasts (ENS) in 97.2% of cases when comparing against more than 1,300 historical events forecast by ENS in 2019. The IFS-based forecasts have long been considered the most accurate in the world. Other companies, such as Microsoft, IBM, and NVIDIA, have also invested into AI-driven weather forecasting.

AI models are trained on decades of historical weather data, often largely on IFS, and based on past insights that allow them to quickly learn to recognize patterns of how future conditions are likely to evolve. Once trained, this efficient process allows AI models to generate forecasts within minutes and requires a relatively small amount of computing power. Conventional forecasting models are run by implementing complicated physical equations on current weather information and observations to determine the predicted future state of the atmosphere. These models, which include those maintained by the US (GFS) and Europe (ECMWF), require significant financial investment and large supercomputers to run.

While traditional weather models still have a prominent place and remain the main resource used in today's weather forecasting, AI and machine learning will continue to improve how we approach the science and add an additional tool to the weather forecasting toolbox. The combination of open-source coding and minimal computing power required to run AI models makes them attractive for expanded use in atmospheric and oceanic sciences.

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Global energy investment tops USD3 trillion

Arguably one of the most critical initiatives in the global transition away from fossil fuels is how governmental entities and the private sector are investing in new technologies and energy sources. Per the International Energy Agency (IEA), total energy investment in 2024 topped USD3 trillion for the first time on record. More than USD2.1 trillion of this total was attributed to global investment in clean energy technology and infrastructure. The IEA observes that investment in clean energy has notably accelerated since 2020, with 64% in 2024 spent on renewable power, grids, and storage. Just a decade ago, investment into oil, gas, and coal accounted for 55% of the total.

The level of investment into clean (renewable) energy comes at a time when cheap financing has dwindled. Borrowing rates have ticked up, following a period of high inflation in the wake of COVID-19 and geopolitical challenges. Higher borrowing costs can particularly hinder clean energy investment, which requires significant upfront financing to cover technology development, construction and installation costs. Many clean technologies are still in an early stage of maturity and investment into research and development (R&D) remains a core expense for both established and start-up companies in this field. Nonetheless, once the assets are operational, there is no ongoing cost for the natural resources they use (chiefly wind and solar energy) — so the vulnerability to interest rates falls away as revenues are used to pay down debt.

Furthermore, the IEA notes that several factors, such as easing supply chain pressures; falling construction costs for renewable facilities (especially wind and solar); and price declines for crucial minerals and metals; appear to be offsetting rising borrowing costs. The growth of government subsidies has further helped to advance new technologies. The Green Subsidies Database, housed by the World Bank, tracks the number of global green subsidies available and splits the environmental objective by sector. The data confirms that China and the United States have deployed the largest number of subsidy programs, while Australia, Canada, and the European Union are also significant players. The challenge, however, is whether these subsidies might lead to complications for international trade and the free flow of goods, services, and technologies as competition grows between countries seeking advantages.

Unsurprisingly, the markets that offer the most incentives also lead the world in renewable energy investment. China has seen a 75% growth in green/clean investment since 2020 alone. The US accounts for 15% of the global total, though for every 1.4 dollars spent another 1.0 dollar is invested in fossil fuels (slightly below the global average of 1.8).

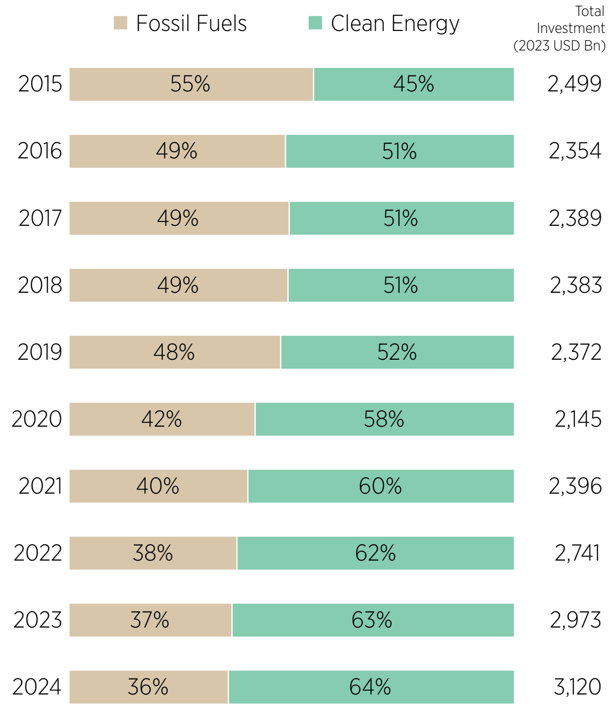


Figure 3: Energy investment (2015-2024) | **Source:** International Energy Agency

There has been notable progress in Brazil, India, Africa, and parts of Southeast Asia. Africa reported USD40 billion of green investment in 2024, which is nearly double its total in 2020. The most urgent need for emerging economies is capital funding for massive improvements to electrical grid systems. Countries with advanced economies account for 80% of global grid spending (though Brazil, Chile, and Colombia did nearly double their investment in 2023 alone).

The insurance industry has an important role to play in this arena. 'Green insurance' policies can provide critical financial security to private sector or federally funded investment projects. This reduction of risk ensures the stability needed to drive further investment. This is notably true for emerging nations that are seeking protections while they transition towards cleaner energy.

Insurance is also playing an increasingly pivotal role in obtaining more climate financing. This can include the introduction of public/private partnerships to establish insurance frameworks; or bringing capital to vulnerable nations seeking funds for adaptation and resilience. Alongside the rest of the industry, Gallagher Re is very active in this area; for example through the placement of parametric insurance products. These are another avenue for risk finance that is complementary to the world's shift towards net-zero targets. The United Nations Environment Programme (UNEP) is also engaging the insurance industry with its Forum for Insurance Transition to Net Zero (FIT), which aims to more effectively communicate a framework that underwriters can use to achieve sustainable initiatives.

Please click here to view Gallagher's 2024 Impact Report which highlights our firm's commitment to sustainability.

Global Natural Catastrophe Overview

Economic Losses

Event Name	Date(s)	Region	Countries	Economic Loss	Insured Loss
Hurricane Helene	Sep 24-28	United States	US	78 billion	20 billion
Hurricane Milton	Oct 7-10	United States	US, MX	35 billion	20 billion
China Seasonal Floods	Summer	Asia	CN	31 billion	0.9 billion
Typhoon Yagi	Sep 1-12	Asia	CH, PH, VN, LA, TH, MM	17 billion	1.0 billion
Rio Grande do Sul Floods	Apr/May	Latin America	BR, UY, AR	15 billion	1.5 billion
Eastern Spain October DANA	Oct 28-30	Europe	ES	12 billion	3.7 billion
Noto Peninsula Earthquake	Jan 1	Asia	JP	12 billion	2.0 billion
Boris / Anett	Sep 11-18	Europe	AT, CZ, RO, HU, DE, SK, PL, SI, IT	9.0 billion	2.3 billion
Arabian Gulf Flash Floods	Apr 13-17	Middle East	AE, OM, YE, BH, QA, IR, SA	8.6 billion	2.8 billion
Hurricane Beryl	Jul 1-12	United States	US, GD, VC, TT, MQ, BB, KY, JM, MX, VE	8.3 billion	3.7 billion
			Grand Totals	**417 billion**	**154 billion**

Table 1: Top 10 costliest economic loss events of 2024 (losses listed in USD); some values rounded | **Data:** Gallagher Re

The direct economic cost of natural catastrophes in 2024 was estimated at USD417 billion. This was 15% above the decadal (2014-2023) average of USD361 billion and 16% above the most recent 20-year average (USD359 billion). When excluding earthquakes and other non-weather perils, the year's total was USD402 billion; or 20% higher than the decadal average (USD335 billion) and 32% higher than the previous 20-year average (USD305 billion). As seen in **Figure 6**, three perils tallied more than USD50 billion in annual losses: tropical cyclone (USD161 billion), flooding (USD109 billion), and severe convective storm (USD84 billion).

There were 60 individual billion-dollar events in 2024; the fifth highest level ever recorded. At least 33 of those events were recorded in the United States alone. The 58 weather/climate-related billion-dollar events ties for the second-highest number on record (73 in 2023 and 58 in 2020). The overall economic toll in 2024 was not record-setting, but it further reinforced the vulnerabilities the world continues to face from costlier 'non-peak' peril occurrences affecting large population centers. High-loss events in Latin America and the Middle East ended in the top ten.

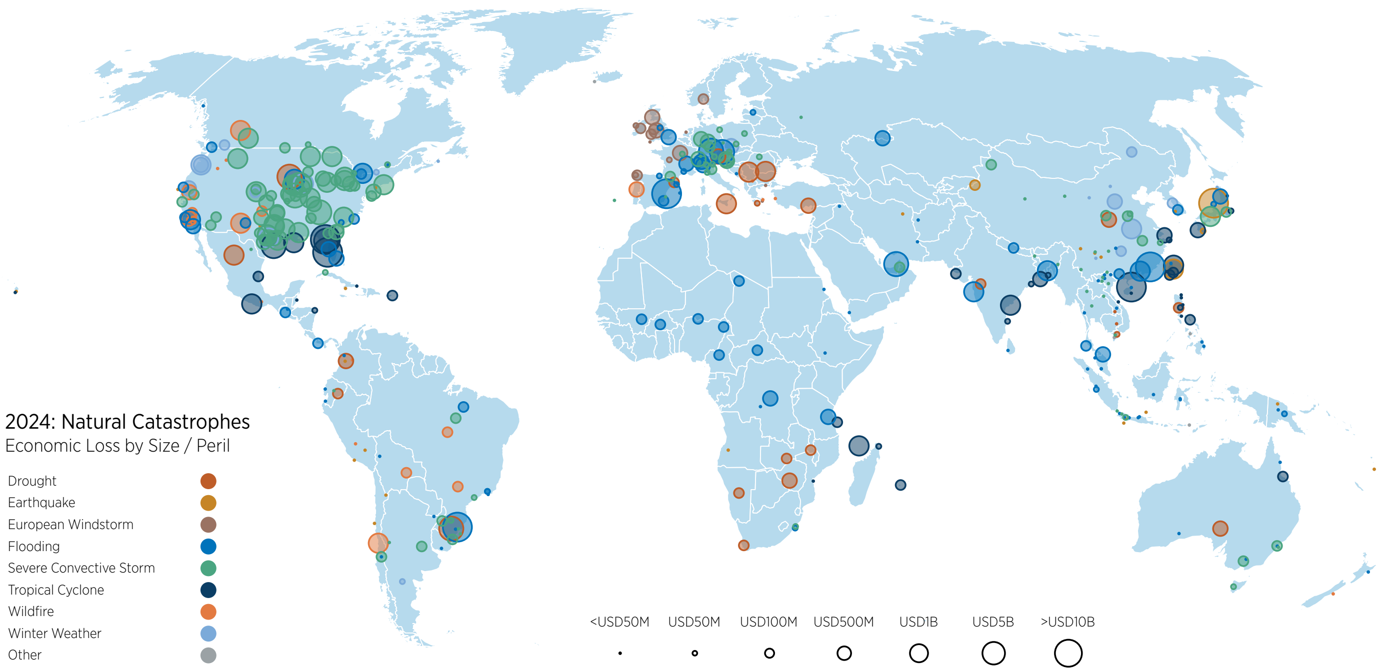


Figure 4: 2024 natural catastrophe map showing economic costs of events by peril | **Data & Graphic:** Gallagher Re

A recent view of global economic losses resulting from natural catastrophes is seen below in **Figure 5**. There has been a generally steady, or perhaps slow upward trend in direct economic costs for weather/climate-related events during this time (+1.8% 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 'peak' perils should dominate annual loss costs, but the reality is that a majority of losses now tend to be driven by 'non-peak' perils in most years. In 2024, non-peak perils accounted for 57% of loss costs — slightly below the decadal average (60%).

While we still anticipate 'peak' perils to drive the highest individual event losses, as we saw in 2024, 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 are leading to higher loss potentials.

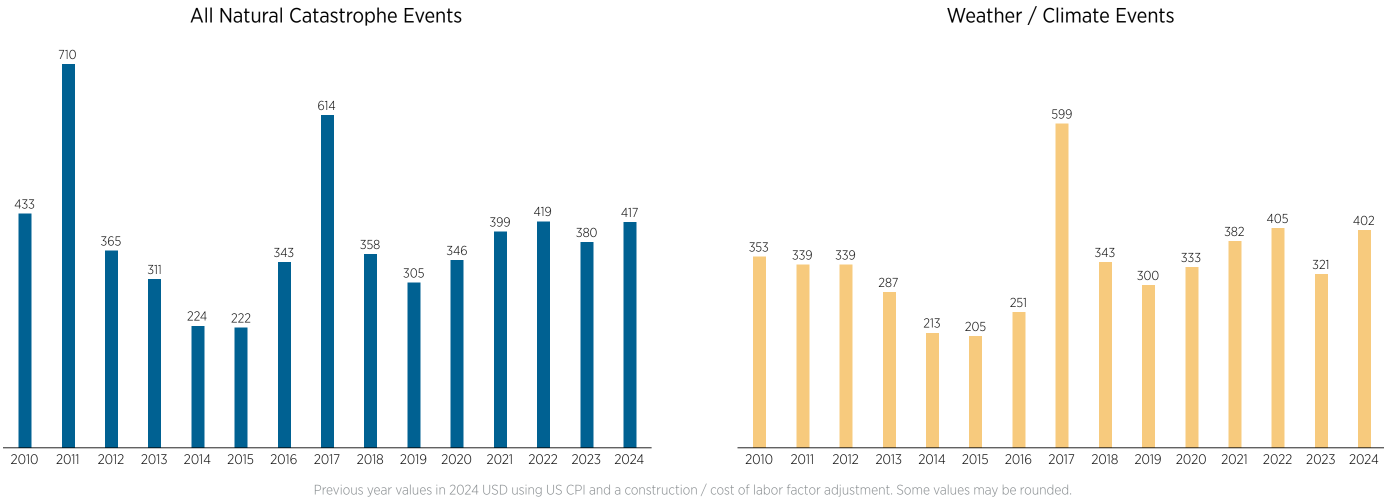


Figure 5: Recent look at annual global economic losses in today's dollars | **Data & Graphic:** Gallagher Re

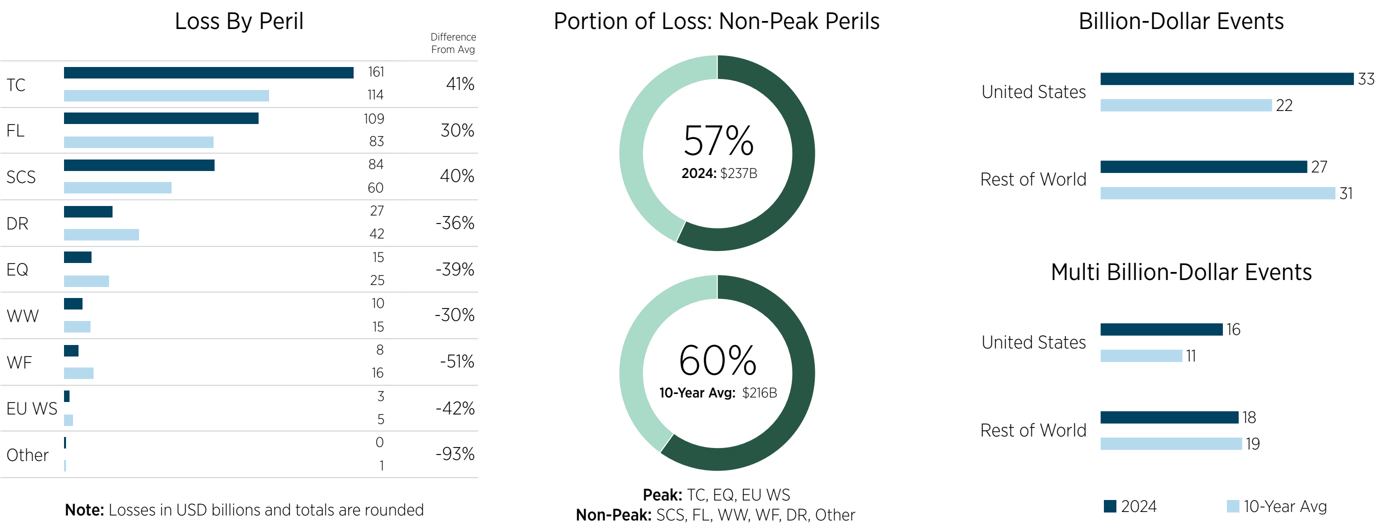


Figure 6: 2024 global economic loss statistics | **Data & Graphic:** Gallagher Re

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

Insured Losses

Event Name	Date	Region	Countries	Economic Loss	Insured Loss
Hurricane Helene	Sep 24-28	United States	US	78 billion	20 billion
Hurricane Milton	Oct 7-10	United States	US, MX	35 billion	20 billion
Early May SCS Outbreak	May 6-10	United States	US	6.9 billion	5.6 billion
Mid-March SCS Outbreak	Mar 12-17	United States	US	6.2 billion	5.1 billion
Mid-May SCS Outbreak	May 17-22	United States	US	5.3 billion	4.2 billion
Late May SCS Outbreak	May 25-26	United States	US	4.9 billion	3.9 billion
Eastern Spain October DANA	Oct 28-30	Europe	ES	12 billion	3.7 billion
Hurricane Beryl	Jul 1-12	United States	US, GD, VC, TT, MQ, BB, KY, JM, MX, VE	8.3 billion	3.7 billion
Hurricane Debby	Aug 4-10	United States	US, CA	6.9 billion	3.7 billion
Arabian Gulf Flash Floods	Apr 13-17	Middle East	AE, OM, YE, BH, QA, IR, SA	8.6 billion	2.8 billion
			Grand Totals	**417 billion**	**154 billion**

Table 2: Top 10 costliest insured loss events of 2024 (losses listed in USD); some values rounded | **Data:** Gallagher Re

The portion of economic losses covered by the private insurance market or publicly run insurance entities in 2024 was estimated at USD154 billion. This total was 27% above the decadal average (USD121 billion), and a further 44% higher than the previous 20-year average (USD107 billion). When excluding earthquakes and other non-weather perils, the year's total was USD151 billion. This was 29% above the decadal average (USD117 billion), and 51% above the 20-year average (USD100 billion). As seen in **Figure 7**, the SCS peril was a dominant factor in the frequency of mid-value loss costs. The peril accounted for 41% of all insured losses globally.

Eleven of the top 20 and four of the top 10 costliest insured events of 2024 were SCS events. All except one, a hailstorm in Canada, occurred in the US. This again illustrates the importance of this peril to the global (re)insurance industry. There were 30 individual billion-dollar events, only behind 2023 (35) and 2020 (32). The 28 weather/climate-related billion-dollar events fell only behind 2023 (34) and 2020 (32) as the most recorded in a single year. The US accounted for 21 of the 30 billion-dollar insured events, including a record 15 which resulted in a multi-billion-dollar loss; surpassing 2020's 14.

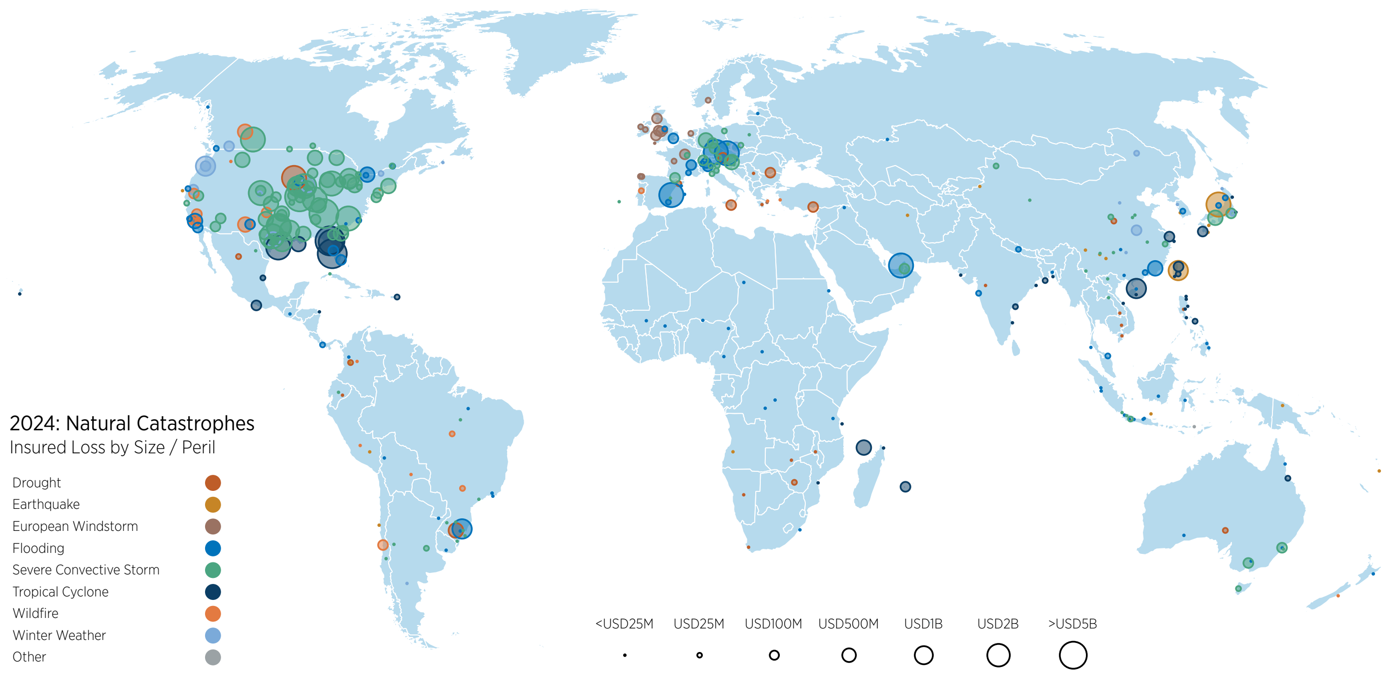


Figure 7: 2024 natural catastrophe map showing insured costs of events by peril | **Data & Graphic:** Gallagher Re

A recent view of global insured losses resulting from natural catastrophes is seen below in **Figure 8**. There has been an increasingly notable upward trend in insured losses during this time (+3.9% 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 (NFIP) and the USDA Risk Management Agency's crop insurance program in the US, or Spain's Consorcio de Compensacion de Seguros ("Insurance Compensation Consortium"). Public / government-sponsored insurers covered nearly USD20 billion of losses in 2024, which was higher than the decadal average of USD12 billion. While progress continues in addressing gaps in global insurance protection, the hard reality is that many vulnerable regions in the world remain uninsured. The need for more guaranteed climate or natural catastrophe financing to mitigate, adapt, or transition economies to more green-based energy production is critical, especially as the complexity of compound risk becomes that much more challenging.

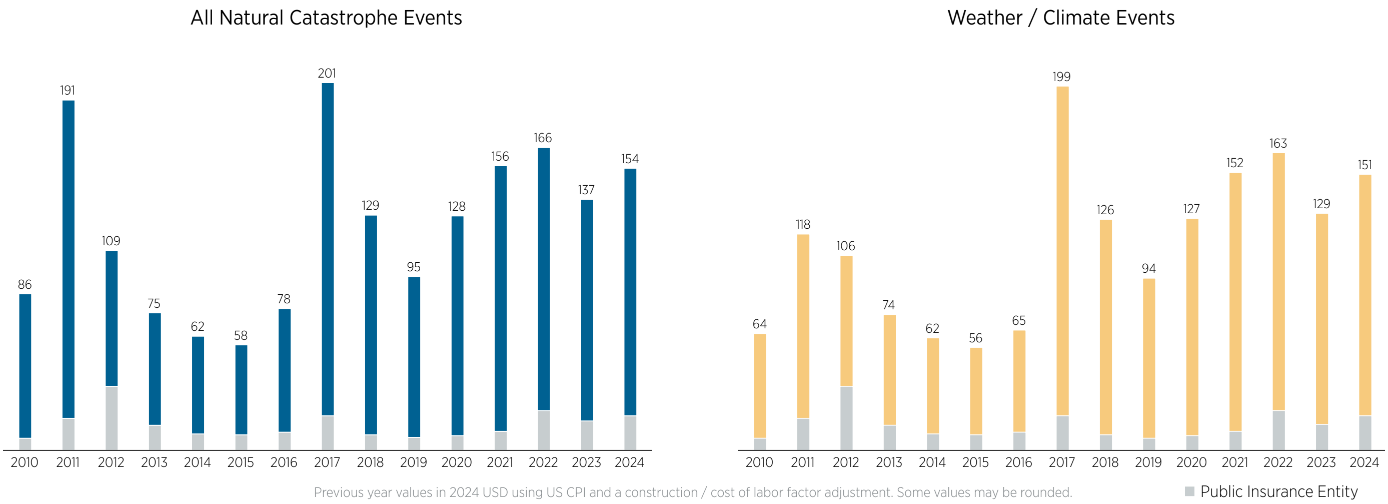


Figure 8: Recent look at annual global insured losses in today's dollars | **Data & Graphic:** Gallagher Re

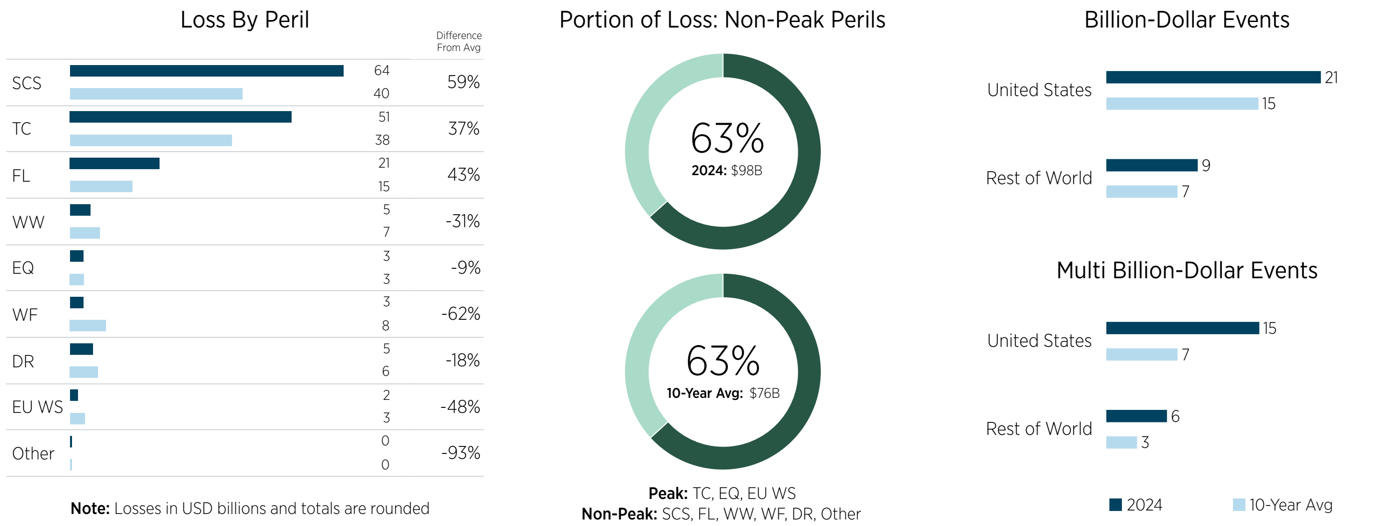


Figure 9: 2024 global insured loss statistics | **Data & Graphic:** Gallagher Re

Regional Analysis

The United States was the major regional driver of losses in 2024, on both an economic and insured loss basis. Besides the US, the only regions that saw economic or insured losses above the short-term averages (five- and ten-year) were the rest of North America and the Middle East. This was illustrated by the fact that Canada and the United Arab Emirates endured their costliest years on record for their local insurance markets. The US accounted for 76% of global insured losses in 2024. For the second year in a row, the Asian continent incurred notably lower than average economic and insured losses. Europe, Latin America, Africa, and Oceania were all either near normal or below average.

The protection gap remains a considerable challenge around the world. The majority of natural catastrophe economic loss costs continue to remain uninsured, which further accelerates the need for more climate financing opportunities. Beyond the increasingly impactful nature of individual events, the influence of socioeconomic factors is also affecting the gap from being lowered. Utilizing more parametric insurance, public-private partnerships, introducing more catastrophe bonds or insurance-linked securities, and financing adaptation projects should be starting point options moving forward. **Figure 10** showcases the decadal protection gap for each region.

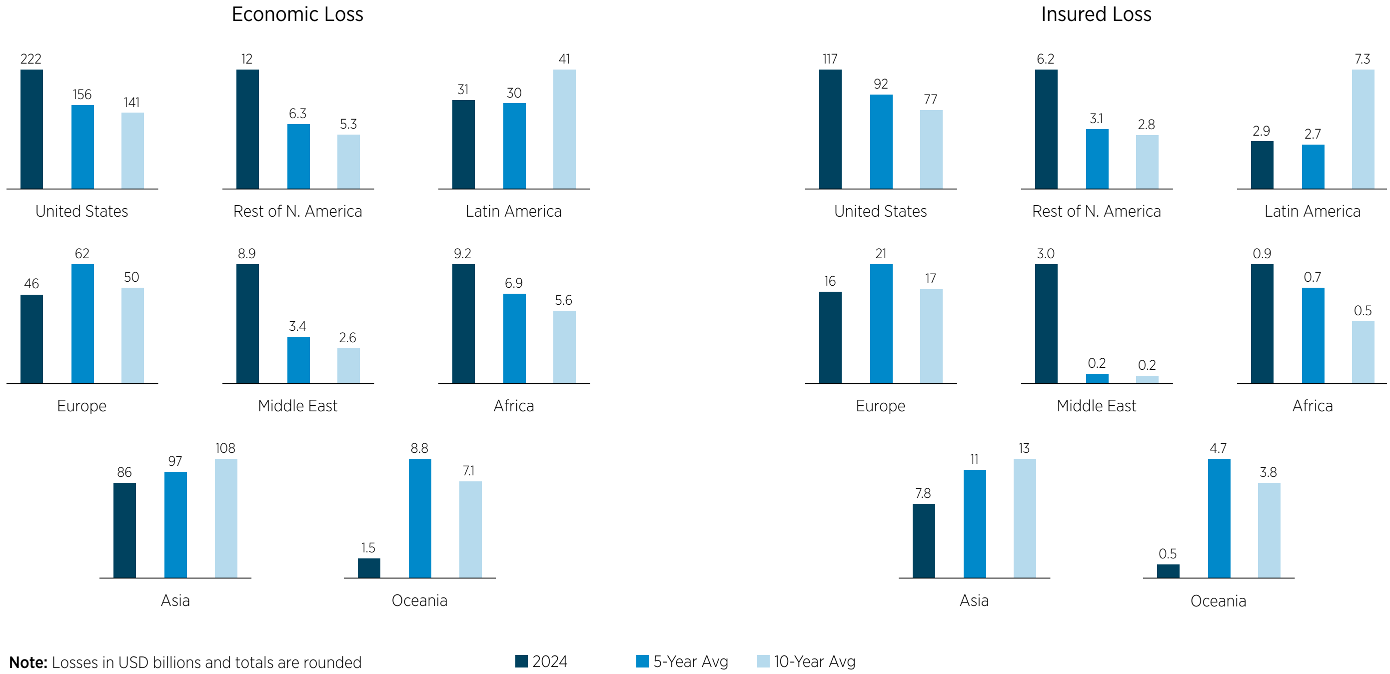


Figure 10: Regional economic and insured losses in 2024 versus recent history | **Data & Graphic:** Gallagher Re

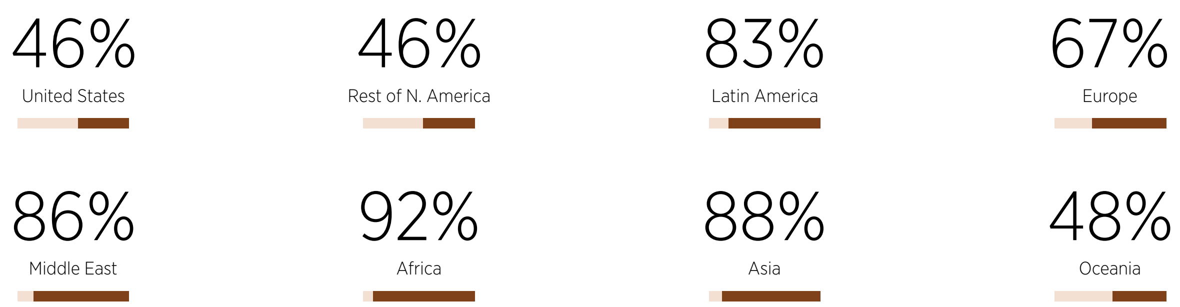


Figure 11: Regional protection gap: 2015-2024 | **Data & Graphic:** Gallagher Re

GUEST SECTION

Sustainability Takeaways In 2024

Zahra Jasmin-Uddin, Kat Couperwhite, Richard Rudden

2024 was a year of significant progress for sustainability in the (re) insurance industry, with shifts in the regulatory landscape, a better understanding of how risks are evolving in this space, and a global decarbonization drive.

The year saw the spread of mandatory climate-related financial disclosures to more jurisdictions across the globe, often with an initial focus on the financial sector. Although these have often primarily targeted banks and investors, global regulators have recognized the need for insurance-specific guidance. The UNEP launched the first ever transition plan guide for insurers at COP29, developed in collaboration with the sector. We also expect to see the consolidation of sustainability reporting in the EU and UK in 2025 to reduce the reporting burden on organizations. Regulation could also influence the way in which we consider local environments and the climate as risk factors in life and health insurance. Examples of this include the Global Action Plan on Biodiversity and Health, first drafted at COP16, which is designed to help curb the emergence of zoonotic diseases, prevent non-communicable diseases, and promote sustainable ecosystems.

Climate litigation is another route by which regulation and policy could impact insurers. Legal challenges against companies and governments for their action or inaction on climate change are becoming more prevalent across the globe, though filings have slowed since 2022. Having previously targeted Carbon Majors (the largest emitters of global carbon emissions), cases are also becoming more sector agnostic. The countries with the highest number of filings also have high insurance penetration rates (e.g. the USA, the UK, and Australia), which further underscores the importance of this topic to the (re)insurance industry. The Gallagher Research Centre has been working with the Grantham Research Institute (GRI) for the past year to track the development of climate litigation globally. We have developed several scenarios to better understand how this risk may manifest across underwriting portfolios. Future work with the GRI will aim to better understand this, through scenarios tailored to (re)insurers' focal points.

2024 saw various carbon credit insurance products launched by both InsurTechs and traditional insurers to address risks in the voluntary carbon market (VCM). For example, Artio, an InsurTech from the Lloyd's Lab accelerator, has been working with Gallagher Re to develop its insurance offering and secure underwriting capacity. Carbon standards now include insurance as a risk mitigation strategy for non-delivery, recognizing the industry's ability to enhance the integrity of the market. In 2023, global carbon compliance markets reached USD949 billion and are expected to grow. There are predictions that the VCM may merge with the compliance markets due to regulatory measures like the EU's carbon removals certification framework (CRCF) and the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA), and potentially reach USD15 billion to USD50 billion by 2030. This highlights the vast opportunities in carbon markets and the need for insurance to build integrity and buyer assurance.

The VCM is just one part of the global drive for decarbonization and net zero by 2050. Renewables, like wind and solar, are now mainstream in reinsurance (although these also have prototypical variations), but successful decarbonization requires support from additional technologies such as carbon capture, green and blue hydrogen, and battery storage to ensure efficient and reliable power systems. Gallagher Re has been supporting clients to understand where their best opportunities lie, aiming for a focused underwriting strategy aligned to a low-carbon future. We are also starting to see decarbonization efforts across industries beyond the energy sector. Both sustainable construction (mass-engineered timber, prefabricated buildings) and nature-positive agriculture demonstrate that climate and sustainability are integral to existing business models.

We will continue to collaborate with our clients to explore and educate on sustainability, putting our expertise at their disposal and helping them to navigate the new opportunities that the energy transition brings.

Zahra and Kat are part of Gallagher Re's Climate & Sustainability group.
Richard is the global head of Gallagher Re's Green Solutions group.

In Focus

What is Driving the Rapid Growth in US Thunderstorm Losses?

The rising financial cost of thunderstorms (severe convective storms) in the United States has become an increasingly important topic of discussion for the insurance industry and beyond. While the physical impacts from tornadoes, hail, and damaging straight-line winds have always been understood to be a high frequency occurrence, this does not always translate to a high frequency of meaningful mid-/high loss events for the insurance market. The peril as it stands now has transitioned to a 'new normal' in which annual nominal insured losses exceed USD40 billion. The recent five-year nominal average (2020-2024) alone is USD42 billion. This is a substantial increase from where losses were roughly 15 to 20 years ago when the 2000-2010 nominal average was roughly USD8 billion. That marks a 425% increase in nominal losses. The following examines why US SCS losses have accelerated so quickly in recent years by looking at recent trends in hazard behavior, the possible link to climate change, and non-hazard causes. The latter are truly the dominant factors in why losses have increased so dramatically.

US SCS hazard frequency & loss analysis

There has been a dramatic improvement in the quality of data recording for the SCS peril in the last 30+ years. With the full nationwide implementation of the WSR-88D Doppler radar system in the early 1990s, plus the emergence of social media and more thorough reporting into the National Oceanic and Atmospheric Administration (NOAA)'s Storm Prediction Center (SPC) by the public, this has worked to reduce uncertainty in possible "misses" of larger tornado or hail outbreaks. However, there are known biases, with data being more robust in urbanized areas.

Given that these two SCS sub-perils typically drive the bulk of annual US thunderstorm losses (the hail peril alone accounts for 50% to 80% of SCS-related filed loss claims), this is an obvious starting point to determine whether there are changes in frequency patterns. For this analysis, and as seen in **Figure 12**, we consider the number of days in a calendar year in which there were ten reports of tornadoes rated F/EF1+ and large hail (two or more inches in diameter) during the "Doppler Radar Era". There has been a very slight upward trend in the tornado data, while large hail shows a much more obvious increase with time. Non-tornadic damaging winds are also included in this analysis (number of days with at least one report with winds gusting to 75+ mph). This also captures impacts from derecho events. The SPC changed its data collection methodology in 2006 to include "Measured Gusts" and "Estimated Gusts". This analysis only includes Measured Gusts. Note: 2024 data is preliminary.

From a local storm report (LSR) perspective the best correlation to the annual increase in insured thunderstorm damage is with large hail and damaging winds. Both are statistically significant; tornado frequency is not. This aligns with industry claims reporting data that suggests the higher frequency of annual losses is being driven by more significant large hail and wind (derecho) occurrences, and less so by strong tornadoes.

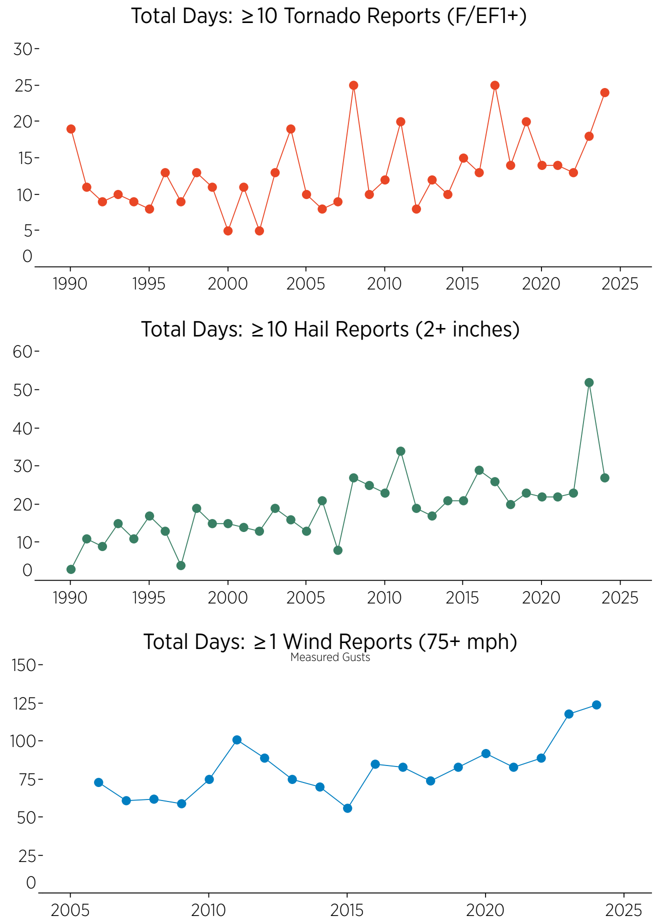


Figure 12: US SCS sub-peril analysis showcasing possible behavior trends
Data: NOAA | **Graphic & Analysis:** Gallagher Re

As already mentioned, the rate of nominal annual average US SCS insured losses has grown by 425% when comparing the nominal 2000-2010 average. As seen in **Figure 13**, the bulk of the losses since 2000 have occurred across central and eastern sections of the country. Texas alone has accounted for 21%, or USD120 billion, of the USD581 billion (2024 USD) in losses. Other states with considerable losses include Colorado (6%), Illinois (6%), Minnesota (5%), Oklahoma (5%), and Missouri (5%). The common theme among these states, especially in parts of the Central/Southern Plains and the Rockies, has been a significant rate of population and exposure growth.

Hailstones cause most damage to roofs, siding, windows and vehicles when they form at a size of 1.5 inches (3.8 centimeters) or greater. The right-hand side of **Figure 13** shows the top 150 US counties that have recorded the most reports of this larger-size hail since 2000. These 150 counties have seen a 36% increase in the number of housing units during this period alone. Note that the bulk of these counties are in the Plains, Rockies, and Midwest. Using the most recent 5-year SCS loss average, and assuming hail accounts for 50% to 80% of thunderstorm-related insurance claims, that means hail is annually costing the industry USD20 billion to USD35 billion. Even though SCS losses typically have high insurance coverage (~80%) from standard homeowner or commercial policies, this means that the total direct economic cost from these events is at least 20% higher.

However, while there are slight indications of a change in hazard behavior/intensity, there are other factors in play that prove to be more substantial. Table 3 shows that Texas accounts for half of the top ten US counties with the highest total increase in housing units since 2000.

County / State	Housing Unit Increase (2000-2023)	Percent Increase (2000-2023)
Maricopa, AZ	652,751	+34%
Harris, TX	648,890	+33%
Los Angeles, CA	400,642	+11%
Clark, NV	397,022	+41%
Bexar, TX	311,682	+37%
Travis, TX	305,774	+47%
Tarrant, TX	290,732	+34%
Riverside, CA	289,356	+33%
King, WA	276,618	+27%
Collin, TX	256,659	+57%

Table 3: Top 10 US counties with highest housing unit growth since 2000
Housing Data: US Census Bureau | **Graphic:** Gallagher Re

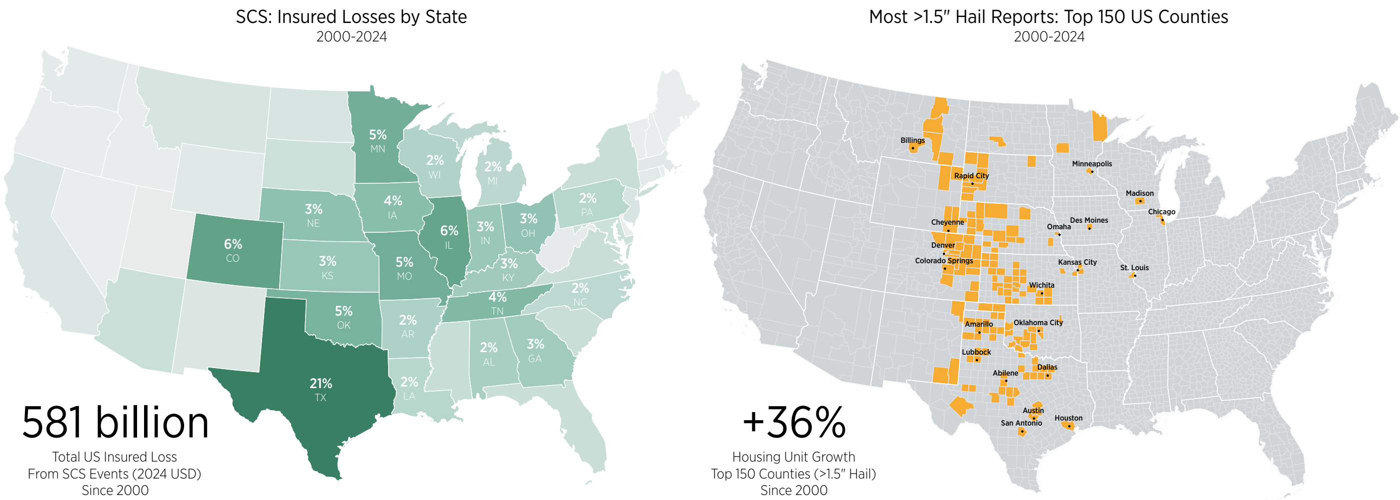


Figure 13: US SCS insured losses by state (left) and the Top 150 counties (right) for hail reports (>1.5 inches) since 2000 | **Data:** NOAA | **Graphic & Analysis:** Gallagher Re

The role of climate change

There is clear evidence that climate change is affecting the weather. Adding more heat and moisture to the atmosphere and warming the oceans is influencing global weather patterns and enhancing favorable conditions. The question now is whether climate change can be cited as a dominant factor in the multi-decadal acceleration of US SCS losses.

Scientific research has already conclusively determined that climate change impacts are not linear. Notable differences are found across each global region and by individual peril. For SCS specifically, the science suggests that this peril has the highest level of uncertainty in how it is projected to behave in a future climate change environment. This is a small-scale phenomenon that is not well resolved by global scale climate models that operate with spatial resolutions of ~150 kilometers. This means that developing a clear understanding of how the peril may be evolving within the current climate is difficult.

Additionally, the change in the risk associated with these perils is not only a function of frequency, but also severity. Using hail as an example, the extent of damage is dependent on hail size and density; both of which are characteristics that can be influenced by climate change. Therefore, while official data compiled by NOAA's SPC does not necessarily suggest any meaningful increase in the total overall number of tornado, hail, and damaging wind reports, it is worth considering that future conditions in a warming environment may eventually bring a more meaningful signal with sub-peril frequency.

Recently published scientific studies note emerging evidence in the US of an eastward and southward shift in where a higher volume of thunderstorms is occurring in addition to a greater number of days that are highly conducive conditions for severe weather. This has been linked to the higher volume of La Niña phases of ENSO in the last 30+ years, which typically shift the steering jet stream deeper into the US Plains and Southeast. NOAA has long concluded that seasons under La Niña tend to produce more frequent/intense thunderstorm outbreaks in the US, while El Niño results in a decline. Additional research has investigated the hail sub-peril and whether there may be an increase in the number of large hail (greater than two inches in diameter) events in future.

One hypothesis is that more atmospheric instability will allow much stronger updrafts in cloud tops reaching higher into the air. This would also mean stronger downdrafts that would reduce the time that larger ice chunks would have to melt prior to reaching the surface. The same study also noted a rise in the 'melting layer height' due to atmospheric warming. This would be expected to reduce the number of small-sized hail reports (<1 inch) and show a higher distribution of large hail reports. The research shown earlier in this section of the number of days with more high-intensity tornadoes, hail, and damaging winds would suggest that individual outbreaks are starting to produce more instances of each sub-peril.

The conclusion? The role of climate change on SCS activity in the US remains uncertain, but growing scientific evidence, coupled with climate modeling, suggests that some clarity may be starting to emerge on how this hazard will be affected in the years ahead.

Primary loss driver: Socioeconomic factors

Having examined the meteorological evidence, there are subtle signs that climate change is contributing to the rapid growth in US SCS losses, but it is not obvious that its effect is significant. So, what about the socioeconomic factors?

By contrast, there is plenty of evidence that socioeconomic factors are significant. The US' urbanized footprint is expanding, with significant growth in the numbers of housing units. At the same time, the cost of construction and roofing/siding material has risen, as has the cost of labor, alongside the general rates of inflation and GDP growth. Our analysis suggests these economic and social effects are clearly the dominant drivers of loss trends.

As seen in **Figure 14**, Gallagher Re has conducted new research to more accurately quantify how the various hazard and socioeconomic factors contribute to the 9.9% US SCS nominal insured loss growth rate since 2000. We conclude that five main non-hazard factors alone account for roughly 80 to 90% of the US insured loss growth. Additional hazard-related factors (including climate change and SCS volatility) drive the rest of the growth trend, alongside miscellaneous reasons (such as an aging built environment, claims litigation, fraud, 'neighboritis' – when a neighbor gets a new roof and you want one too, etc.) Such results are consistent with other published analysis and underscore that assessing how and where we build (or rebuild) is a critical component in fully understanding the totality of SCS or any other natural catastrophe risk.

This does not minimize in any way the growing risks associated with changes in hazard frequency or behavior. The takeaway can suggest that despite significant improvements in construction practices and quality of building material that the rate of loss increase must be at least partially linked to a change in hazard behavior that is overriding some of these built environment improvements. However, the reality remains that the outward expansion of urbanized areas into suburban or exurban communities has expanded the 'bullseye' for potential damage regardless of any climate change influence on frequency. This aligns with research first published by Ashley, et al in 2014. States, emergency managers, real estate, primary insurance companies (underwriters), and even local homeowner associations must take these realities into account to promote or incentivize better building practices.

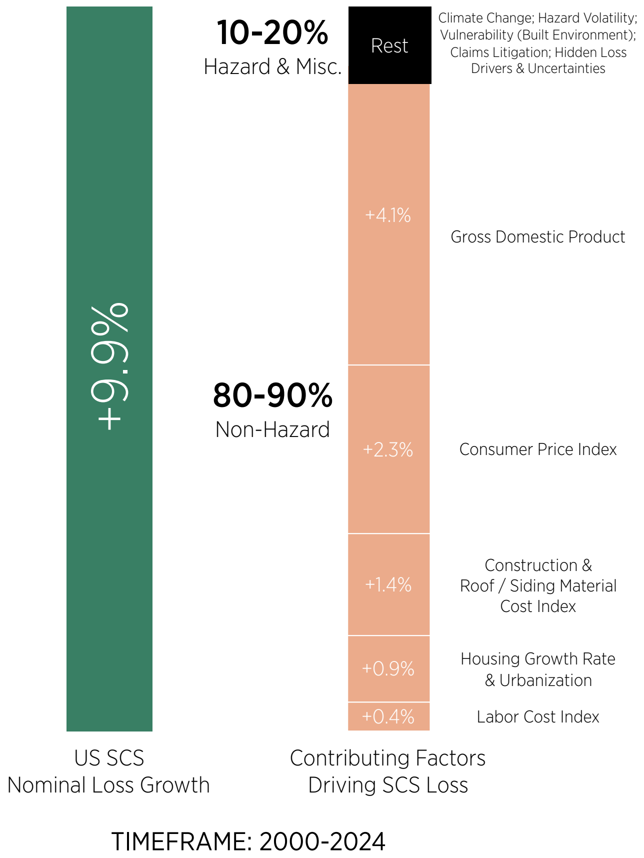


Figure 14: Contributing factors of US SCS loss growth since 2000
Socioeconomic Data: US Census Bureau | **Loss Data & Graphic:** Gallagher Re

SCS risk beyond the United States

While the United States is the epicenter of global insured thunderstorm losses, it is not the only region seeing an evolution in such losses impacting local (re)insurance markets. Parts of Europe, Asia, Oceania, the Americas, and even Africa have all recorded locally significant SCS events in the last decade alone that have reshaped how the peril is priced and viewed. The peril, unsurprisingly, now represents an increasingly larger proportion of losses for local markets.

Portions of Europe have seen an uptick in the volume of large hail reports with time. Research from the European Severe Storm Laboratory (ESSL) has shown that northern Italy is one specific area that has seen an uptick of large hail (2+ inches/5+ centimeters) since the 1950s. Escalating storm frequency and intensity has been aided by more humidity in the lower atmosphere in tandem with changes in atmospheric circulation patterns. Europe is one part of the world where there is greater scientific confidence in the role of climate change affecting thunderstorm intensity, frequency, and regionality. Italy recorded its most prolific SCS event on record in the summer of 2023, when large hail (including a 7.48-inch (19.0-centimeter) hailstone) resulted more than USD6.3 billion in insured losses. Outbreaks in France during the summer of 2022 also saw hail-driven insured losses top USD4.5 billion.

SCS risk is further taking on more prominence in parts of APAC and Latin America, too, where hail events are again driving notable loss costs for local insurance markets and governmental agencies. Australia, as an example, is particularly vulnerable to SCS risk. Data from the Insurance Council of Australia (ICA) cites that SCS outbreaks (many driven by hail) account for 15 of the ICA's top 40 costliest normalized insured loss catastrophe events on record. The country's costliest industry event on record was the April 1999 Sydney hailstorm that nominally cost USD1.1 billion, but after accounting for today's exposure, building construction improvements, and wealth increases, that total is USD5.8 billion in today's dollars. Hail risk is even noted in parts of Japan, where the country's Hyogo region experienced close to a billion-dollar insured loss in April 2024. The risk further extends into the Americas, notably in Canada and parts of Brazil and Argentina. Canada's geography and exposure growth brings with it SCS risk that is similar in nature to the United States. Alberta province is known for catastrophic hail events that have led to billions (USD) in insured losses in the Calgary metro region alone in just the past few years. Latin America's SCS risk extends beyond just to physical property, but also to vitally important agricultural regions in Brazil and Argentina.

Final thoughts

The cost of SCS events continues to grow, and the US remains the global thunderstorm loss capital of the world. While there remains a lack of clear evidence in an SCS frequency growth rate in most regions of the world, improvements in data quality and advancing scientific research does suggest that the combination of spatial shifts in event location and an apparent emergence of higher frequency tornado or hail occurrences per outbreak is becoming more evident. While this is important research, it must not be treated as the sole justification for loss growth. We've clearly concluded that broader socioeconomic factors are driving a substantial portion of the accelerated loss growth. However, it is important to recognize that a combination of hazard behavior and frequency trends, socioeconomic factors, and the prospect of an amplified climate change influence is expected to keep driving annual SCS loss costs to new heights.

Bringing together regional and local governmental entities, academic and engineering researchers, construction and real estate leaders, and the insurance industry to discuss the importance of adaptation financing and building code improvement/enforcement will be key factors in lowering global SCS physical risk. Developing unique insurance coverage schemes, such as parametric solutions, can also be viewed as gap fillers where insurance availability or reinsurance protection for primary carriers may be limited. This can also be a valuable solution for the agricultural sector, which is likewise suffering greater SCS losses that could affect potential yields.

SCS has long outgrown the 'secondary/non-peak' peril status. How we address the risks and implement mitigation strategies, as well as improve our early warning detection process, will be key. Understanding the risk is the first step. Acting to better prepare and minimize loss potential against the risk must be the next.

A Perspective on Climate Risk Management for (Re)insurers

The insurance industry is increasingly finding that its regulatory bodies are proposing (and, in most cases, mandating) the use of climate scenario analyses to assess the extent and impact of future climate risks. For the industry's risk managers, however, this task is not entirely straightforward. A typical analytical approach, such as using operational tools (e.g. catastrophe modeling), provides specific, but limited insights based on adjusting only the hazard element of the model. Assessing and managing climate risk requires a flexible approach that reflects the full spectrum of outcomes. This would include a strategy for handling uncertainty and flexible methods that can be augmented as new science and technology emerge. Robust risk management implies exploring risks beyond the consensus view. This is especially important if more tail events occur, possibly bringing the world closer to climate tipping points.

Conducting regulatory scenario exercises should provide ample context for a fuller risk assessment, but it is crucial to ensure the scenarios fully explores the plausible uncertainty space. Regulators and financial institutions should work directly with climate scientists, or other appropriate academics, to ensure these exercises translate to practical or usable output.

Types of climate risks

For financial risk management, climate risk takes (at least) two forms, physical and transition risk. Physical risk looks at how weather / climate events may change in intensity, frequency, or location. Transition risk covers anything linked to the transition of society towards a net-zero emission environment. The two risks are implicitly intertwined, and if society aggressively pursues net-zero ambitions, the transition risk will be more pronounced and should limit some of the worst-case impacts of physical climate change.

A practical example of interaction amongst different types of risks is the potential growth in climate litigation through direct or indirect liability. The rise in climate litigation cases suggests this is a very real risk that the industry will need to address. Whether a company is viewed as either too active or inactive can add another layer of complexity in understanding how the totality of climate risk may lead to fiscal or reputational stress.

For the insurance industry, another key consideration is the timescale of the climate risk. The insurance sector typically works to a one-year timescale, because standard policy windows extend in 365-day increments. Other financial institutions, such as mortgage lenders or asset managers, may be looking at an investment spread out across decades. It is also important to consider timescale in the direction of organizations needing to develop policies to mitigate against future risks at various future time intervals.

Insurers are likely to be most immediately focused on understanding physical risk in their portfolios. This requires further defining chronic and/or acute risks. The World Bank defined both in their 2022 report Assessing Financial Risks from Physical Climate Shocks: a Framework for Scenario Generation. A chronic risk is one that results from "..gradual shifts in bio-physical and climate characteristics over time due to climate change. This includes, for example, changes in labor productivity due to gradually warming temperatures or reductions in agricultural output due to shifting rainfall patterns." Conversely, acute risks are defined as "..changing frequencies or severity of shocks, such as natural catastrophes, including flooding, tropical cyclones, wildfire, heatwaves or droughts." Essentially, chronic risks should be interpreted as the societal impacts of global warming and acute risks are more closely linked to an amplification of weather driven hazards. It is easy to see why the latter are more readily intuitive for insurers assessing the risks in a property insurance policy that renews in a year's time.

Yet as losses emanating from both acute and chronic risks continue to rise, this is prompting a more targeted reassessment of portfolio risk and pricing by the private insurance market. This is where the topic of insurability becomes increasingly relevant to risk management. The question becomes if the regularity of currently deemed 'rare' events occur with greater frequency in the future, will this structurally change how the insurance industry views the viability of insuring some regions or specific perils. This justifies the growing popularity of public / private partnerships to ensure more financial protection for highly vulnerable regions.

Linking climate risk to business risk

Any risk assessment exercise is only relevant and useful if it clearly identifies how the risks identified relate to business operations and strategic planning. Climate risk is no different. Table 4 (taken from guidance issued by EIOPA) provides several examples of the "transmission channels" by which climate risks come to have direct impacts upon insurance business. Such guidance, which is also similarly provided by regulators in parts of Asia, Oceania, North America, and Latin America, is very useful as the industry better identifies its risk exposures and works to establish more effective key performance and risk indicators.

Estimating climate stress variables

A central component of scenario analysis is the climate stress test, which can be used to test a firm's ability to withstand higher losses or financial shocks, and thus critical to assess future solvency. From a physical risk standpoint, climate stress tests typically involve a numerical adjustment of the hazard component in a catastrophe model or making a simple factor adjustment from a current baseline value. Such an adjustment is typically based on information produced by the climate science community, but this is not always the case. Most scenarios are taken from dozens of global circulation model (GCM) experiments that are coordinated by the World Climate Research Programme (WCRP) initiative known as the Coupled Model Intercomparison Project (CMIP). This data is one of the key resources underpinning the Intergovernmental Panel on Climate Change (IPCC) report series which is released and updated once or twice per decade. (For more background on climate projections, see Box 1.)

Since risk management based on far-future time horizons (>20 years) is still an emerging need and practice within the insurance industry, there is not much consistency in how climate projections are conducted nor a standardized approach in making hazard component adjustments. However, there is an increase in weather / climate agencies that are supporting the development of industry standards in climate services. Major international initiatives such as the World Meteorological Organization's Global Framework for Climate Services (GCFS) is building toolkits and guidance on national, regional and global levels. Additionally, the core project of the Regional Information for Society (RIfS), as part of the WCRP, is currently building capacity to coordinate research with an aim to provide actionable climate projection information at regional scales.

Transmission channel	Balance sheet impact	Example
Physical Climate Risks		
Underwriting Risk	Liabilities	Higher than expected insurance claims on damaged insured assets (non-life) or higher than expected mortality or morbidity rates (life/health)
Market Risk	Assets	Impairing of asset values due to financial losses affecting profitability of firms, due to for instance business interruptions, or damage to real estate. Specific example: equity price shocks
Credit Risk	Assets	Deteriorating creditworthiness of borrowers/bonds/counterparties/ reinsurers due to financial losses stemming from climate change. Specific example: bond price/yield shock
Operational Risk	Assets	Disruption of own insurance activities and/or assets, such as damage to own property
Liquidity Risk	Assets/ Liabilities	Unexpected higher payouts and/ or lapses as broader economic environment deteriorates
Climate Transition Risks		
Market Risk	Assets	Impairment of financial asset values due to low-carbon transition, for instance stranded assets, 'brown' real estate and/or decrease in value of carbon/GHG intensive sectors. Specific example: equity price shock
Credit Risk	Assets	Deteriorating creditworthiness of borrowers/bonds/counterparties
Underwriting Risk	Liabilities	Decrease of underwriting business due to increase of insurance prices in response to higher -than -expected insurance claims (non-life) or changes in policyholders' expectations and behavior related to sustainability factors (, e.g. green reputation) (life)
Underwriting Risk	Liabilities	Higher than expected claims on professional indemnity cover, as parties are held accountable for losses related to environmental damages caused by their activities
Legal or Reputational Risk	Assets / Liabilities	Insurers could be held responsible for climate change and/or not doing enough to mitigate/adopt

Table 4: Example of climate risk transmission channels
Source: EIOPA (reproduced from EIOPA-BOS-21/579, Table 1-2)

Final remarks

The purpose of risk management is to identify risks and propose actions or strategies to meet those risks. While it will never be a precise exercise in understanding every nuance of climate risk at a multi-decadal time horizon, any attempt should be viewed as a worthwhile process in better understanding how risk profiles will evolve. The key is acknowledging the deep uncertainties around future emission pathways and limits to what information can be expected from climate science. Being transparent in stating the uncertainty is an important part of the process, and presenting a range of options is much more realistic than expecting precision.

It must be noted, however, that predicting future hazards and loss performance is not necessarily the sole purpose of regulators' climate scenarios and stress tests. Such frameworks are best described as capacity-building or awareness-raising exercises intended to explore how to better understand possible shocks that may propagate through risk transmission channels.

The present-day approach to stress tests usually involves the adjustment of only the hazard component (i.e. how bad climate change will be; how much more extreme weather events will become). While currently useful, more sophisticated approaches involving a future built environment, emission scenario projections, policy implications, and other factors will need to be implemented in the years to come. More parameters may equal more uncertainty, especially in understanding how these parameters may directly or indirectly influence one another, but the global risk profile is complex and not easily understood.

If done effectively, well-designed scenarios and stress tests should be able to help the insurance industry and other private sector entities effectively monitor and plan for change.

HOW CLIMATE PROJECTIONS WORK

To assess how the world may look in the future as global warming develops, two pieces of information are needed: 1) Information about how emissions, pollutants and land-use may change; 2) Understanding how the earth system responds to such physical changes.

The first challenge is addressed by the Integrated Assessment Model (IAM). The basic function of an IAM is to represent the human-caused drivers of climate change; i.e. the sources of greenhouse emissions. The output is a series of projected trajectories for emissions, which are then post-processed before being used to populate emission fields in a climate model.

Climate models are sophisticated numerical models that simulate the movement of mass, moisture, heat and momentum in the earth system. They help tackle our second challenge. There are many different types of configurations of these models. Most models have representations of the atmosphere, ocean, land surface, sea ice, marine chemistry, etc. The most complex configuration is the Earth System Model (ESM) that further includes a representation of the carbon cycle and other critical bio-geophysical systems. The global coordinator in such modeling work is the World Climate Research Programme (WCRP) through its Coupled Model Intercomparison Project (CMIP). CMIP is conducted in phases, with sub-committees supporting the design of experiments to best address model limitations or explore model capabilities. The very latest phase of experiments (CMIP7) was recently defined, and new projections are expected in 2027.

The primary use of the GCMs is to build new knowledge about the climate system. A secondary use is climate services, where outputs are used to inform risk assessments, provide policy guidance, or motivate adaptation actions. However, because the typical output from the GCM is of too coarse a resolution for many real-world applications (typical scale ~150km), many users opt to use downscaled products. These are regional resolution projections derived from the global-scale model output. Downscaling is an umbrella term, including both statistical and dynamical methods, some nearly as complex as the global-scale climate model itself.

When working with climate projection information, it is critical that users attempt to represent uncertainty. A large spread in model output is to be expected. Uncertainties in climate modeling are usually attributed to three sources: 1) Natural variability; 2) Scenario uncertainty; 3) Model uncertainty. Natural variability can be explored by changing the initial starting conditions; scenario uncertainty involves the exploration of different emission trajectories; and model uncertainty can be explored by analyzing outcomes from a model ensemble rather a single model. While interpreting GCM output is not trivial, there are publicly available tools that simplify and visualize the output, such as the IPCC Working Group I Interactive Atlas or the Climate impact explorer of Climate Analytics.

GUEST SECTION

2024 Tropical Cyclone Review

Phil Klotzbach, Michael Bell, Levi Silvers

Global tropical cyclone activity

The 2024 global tropical cyclone season ended up slightly below normal, with 86 named storms, of which 42 became hurricanes and 23 became major hurricanes (Category 3+). In an average calendar year, the globe has a total of 88 named storms, of which 48 become hurricanes and 26 become major hurricanes.

In the Northern Hemisphere, the North Atlantic was hyperactive, while the eastern North Pacific, western North Pacific and North Indian Ocean seasons ended below normal. The Atlantic/Pacific dipole in tropical cyclone activity is common in cool neutral or La Niña conditions. While not officially meeting NOAA's definition of La Niña, the atmospheric circulation in mid to late 2024 was reflective of La Niña conditions. Since the Pacific typically has more hurricane activity, La Niña conditions tend to drive down Northern Hemisphere hurricane numbers.

Southern Hemisphere tropical cyclone activity was near to slightly below normal. The South Indian Ocean (west of 135°E) saw near normal activity, and the South Pacific Ocean (east of 135°E) had slightly below-normal activity. The lack of South Pacific Ocean activity despite El Niño during the start of 2024 was surprising. Typically, South Pacific activity is elevated during El Niño phases.

Hyperactive Atlantic season

Most notable was the hyperactive 2024 Atlantic hurricane season. Gallagher Research Centre's partners at Colorado State University issue seasonal hurricane forecasts in which they correctly anticipated the hyperactive season. Depending on lead time, our forecasts called for 23–25 named storms, 11–12 hurricanes and five-six major hurricanes. The season ended with 18 named storms, 11 hurricanes and five major hurricanes. The lack of weaker storms relative to stronger storms was partially attributed to higher levels of vertical wind shear in the subtropics (where weaker storms tend to form).

Five hurricanes (Beryl, Debby, Francine, Helene and Milton) made landfall in the continental US, with Helene and Milton being the most destructive. The season got off to a fast start, with Hurricane Beryl becoming the earliest Atlantic Category 5 hurricane on record. However, from August 20 — September 23, the Atlantic generated the least Accumulated Cyclone Energy (ACE) between those dates since 1994. This mid-season lull was due to several factors including a northward shift in the track of African easterly waves (e.g. strong thunderstorm complexes which serve as seeds for hurricanes). These waves emerged into the Atlantic where waters were often too cold and the air too dry to support development. Upper-level temperatures were also very warm, creating a more stable atmosphere and suppressing deep convection.

The Atlantic became active after September 24, with seven of the 11 hurricanes forming during this time — the most on record. The hyperactive finish to the season was due to hurricane-favorable phases of the Madden–Julian Oscillation (MJO), record low vertical wind shear, warm sea surface temperatures and cooler upper-level temperatures.

Rapid intensification

We have been studying the relationship between ENSO and rapidly intensifying tropical cyclones. Rapidly intensifying storms were defined as named storms that intensified by >=35 mph (56 kph) in a 24-hour period.

While the summer and fall seasons did not officially qualify as La Niña based on NOAA's traditional Oceanic Niño Index (ONI), if we used the Relative Oceanic Niño Index (e.g., sea surface temperatures in the eastern/central tropical Pacific minus the tropical average), the season did meet the La Niña threshold. We generally find increases in storms undergoing rapid intensification in the North Atlantic and North Indian Ocean in La Niña years, with decreases in rapid intensification in the eastern and western North Pacific.

In 2024, seven Atlantic named storms underwent rapid intensification, above the La Niña average of six storms and the long-term average of four storms. In the eastern North Pacific, only three storms underwent rapid intensification, below the La Niña average of five storms and the long-term average of six storms. In the western North Pacific, 12 storms underwent rapid intensification. Despite being a slightly below-average overall season, the western North Pacific did have more rapid intensification storms than the overall average (10), and well above the typical average during La Niña seasons (seven). One North Indian Ocean tropical cyclone underwent rapid intensification — close to the long-term average.

Since ~80% of all Southern Hemisphere rapidly intensifying storms occur between January and April, a period that was characterized by El Niño conditions in 2024, we would expect these basins to have rapid intensification characteristics like El Niño. Eight tropical cyclones underwent rapid intensification in the South Indian Ocean, which was above the long-term average of six. Historically, there is relatively little difference in storms undergoing rapid intensification in El Niño (six) than in La Niña (seven) in the South Indian Ocean. Surprisingly, only one tropical cyclone (Megan) underwent rapid intensification in the South Pacific in 2024. This is well below the El Niño average of five tropical cyclones and the long-term average of three tropical cyclones.

Final remarks

While there were some notable discrepancies between this year's global tropical cyclone activity and the typical relationships with El Niño/La Niña, the overall slightly below-normal tropical cyclone season was in line with historically observed relationships with ENSO. The Northern Hemisphere produces ~70% of global hurricanes and since the Northern Hemisphere summer/fall was characterized by cool neutral ENSO or weak La Niña conditions, a slightly below-normal global tropical cyclone season would be anticipated.

Colorado State University is a collaborator in the Gallagher Research Centre's Tropical Cyclone Consortium

Weather / Climate Review

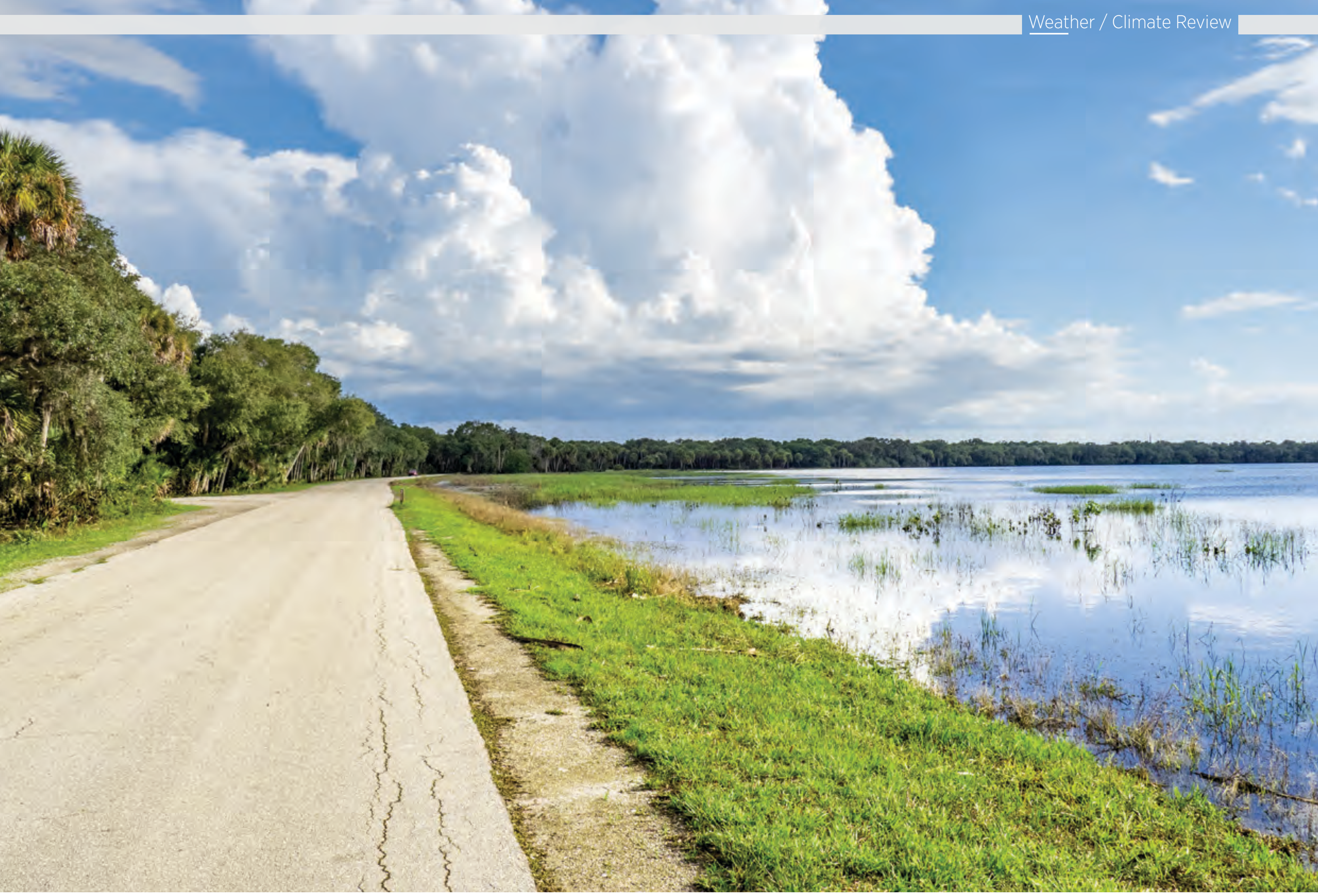
2024: Warmest Year Ever Officially Recorded; Tops Previous Record Set in 2023

2024 was unanimously acknowledged as the warmest year globally on record by several official global agencies (NOAA, NASA, Berkeley, UK Met Office, JMA, Copernicus). According to NOAA, the year was 1.29°C (2.32°F) above the 20th century baseline, and 1.46°C (2.63°F) above the pre-industrial baseline (1850-1900). The record warmth was driven by the lingering effects of El Niño conditions, record shattering heat in the world's oceans, and further evidence of the fingerprints of climate change. For the first time on record, global monthly temperature anomalies based on the 20th century baseline exceeded 1.0°C (1.8°F) in every single month in the calendar year. The streak first began in June 2023.

Multiple global agencies registered that the globe surpassed the 1.5°C (2.7°F) threshold 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 further significant climate effects. However, the Paris Agreement language notes that the 1.5°C (2.7°F) would officially be surpassed once it is averaged across a 30-year period. This is the standard timeframe for climatological averages. The fact that various agencies have indicated that 2023 and 2024 have topped this threshold means the globe continues its steady rate of atmospheric and oceanic warming.

Rank	Year	20th Century Baseline	Pre-Industrial Baseline
1	2024	1.29°C / 2.32°F	1.46°C / 2.63°F
2	2023	1.19°C / 2.14°F	1.36°C / 2.45°F
3	2016	1.03°C / 1.85°F	1.20°C / 2.17°F
4	2020	1.02°C / 1.83°F	1.19°C / 2.15°F
5	2019	0.98°C / 1.77°F	1.16°C / 2.08°F
6	2017	0.94°C / 1.69°F	1.11°C / 2.00°F
7	2015	0.91°C / 1.65°F	1.09°C / 1.96°F
8	2022	0.90°C / 1.62°F	1.07°C / 1.93°F
9	2018	0.87°C / 1.57°F	1.05°C / 1.88°F
10	2021	0.87°C / 1.56°F	1.04°C / 1.87°F

Table 5: Top 10 warmest years for temperature anomalies showing baselines for the 20th Century (1901-2000) and the Pre-Industrial Era (1850-1900)
Source: NOAA



To highlight the various agencies reporting that 2024 was the warmest year on record, **Figure 15** provides a comparison of five separate recording agencies (NOAA, NASA, UK Met Office, Berkeley Earth, JMA). Each agency incorporates a unique methodology that typically involves bespoke interpretations meant to de-bias observed measurements from land and ocean instrumentation. These different approaches often lead to slight differences in final reporting numbers — which also include the incorporation of uncertainty ranges — that help address the expectation of interpolation errors. Despite the slight annual differences, each agency conclusively showcases steady multi-decadal warming for the planet.

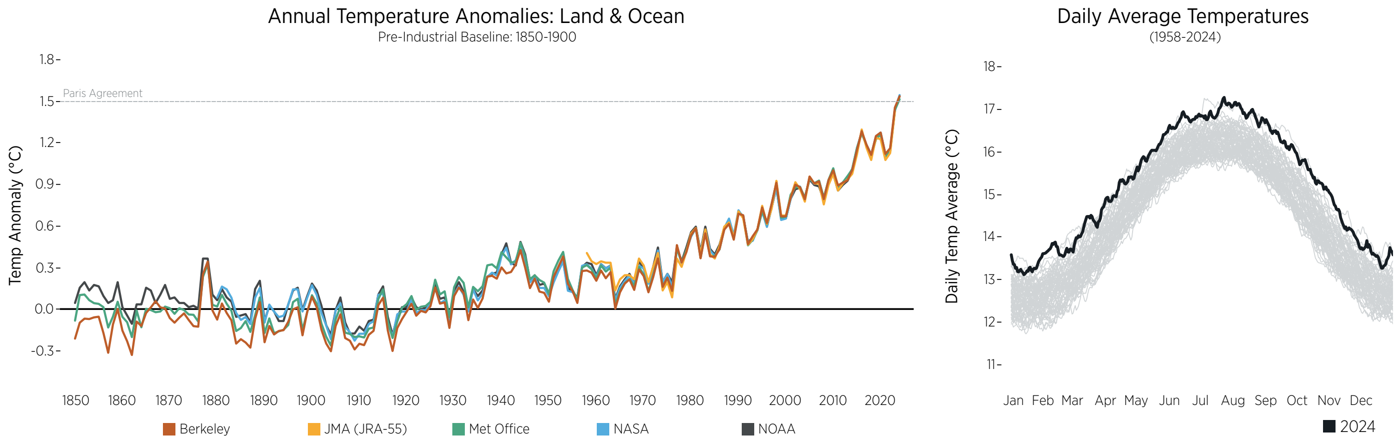


Figure 15: Annual global land & ocean temperature anomalies vs the pre-industrial baseline (left) and daily global temperature average (right) **Data:** NOAA, NASA, Berkeley Earth, UK Met Office, Japan Meteorological Agency (JRA-55) | **Graphic:** Gallagher Re

2024 global review: Temperature and precipitation anomalies

Climate change and a predominately neutral range of the El Niño–Southern Oscillation (ENSO) capped 2024 with sustained above-normal temperature anomalies. Every month in the calendar year was either the warmest or second warmest on record. Per Copernicus, the 12-month average temperature concluded 0.72°C (1.30°F) above the 1991-2020 climatological baseline, or 1.60°C (2.88°F) above the pre-industrial baseline. All ten of the warmest years on record dating to 1850 have occurred since 2015.

Only a select few areas of the globe were cooler than average: these included Iceland, and parts of the Himalayas. The rest of the globe saw near- to above-normal warmth. Areas with a temperature anomaly near or above 2°C included eastern Canada, northeastern US, Mexico, Peru, Paraguay, Iran, Yemen, western Mongolia, China, South Korea, Japan, Central and Eastern Europe, and Northern and Central Africa. Heavy rain and flood events in Central Europe, the Arabian Gulf, eastern Africa, northern Vietnam, northeastern and southeastern China did not lead to the extensive cooling period required to meaningfully lower the full-year temperature average. Those events were largely modulated by prolonged heatwave episodes that tended to arrive earlier and last longer into the calendar year amid the ongoing trend of rising global temperatures.

Anomalous warmth was expected to persist into the first few months of 2025. This is despite the expectation that emerging and weak La Niña conditions may be present. Such conditions typically lead to slightly cool global temperatures. However, the wildcard will remain ocean temperatures, which have been significantly above normal for more than a calendar year. Recent climate change-fueled heat has increased energy demand for cooling, which slows progress toward emissions-cut targets. The growth of manufacturing and data centers will promote further near-term warming as fossil fuel usage from power generation prompts more near-term emissions. The burning of fossil fuels releases greenhouse gases into the atmosphere which trap heat and subsequently warm the Earth.

Figure 16 visualizes global temperature anomalies in 2024. The red colors indicate warmer than normal, and shades of blue showcase cooler than normal. Larger regions of the globe were warmer than were cooler. While not shown on this graphic, as previously noted, sea surface temperatures (SSTs) in the oceans were abnormally warm, driving marine heatwaves. These enhanced more extreme weather patterns globally and provided additional fuel for tropical cyclones that aided in rapid intensification episodes.

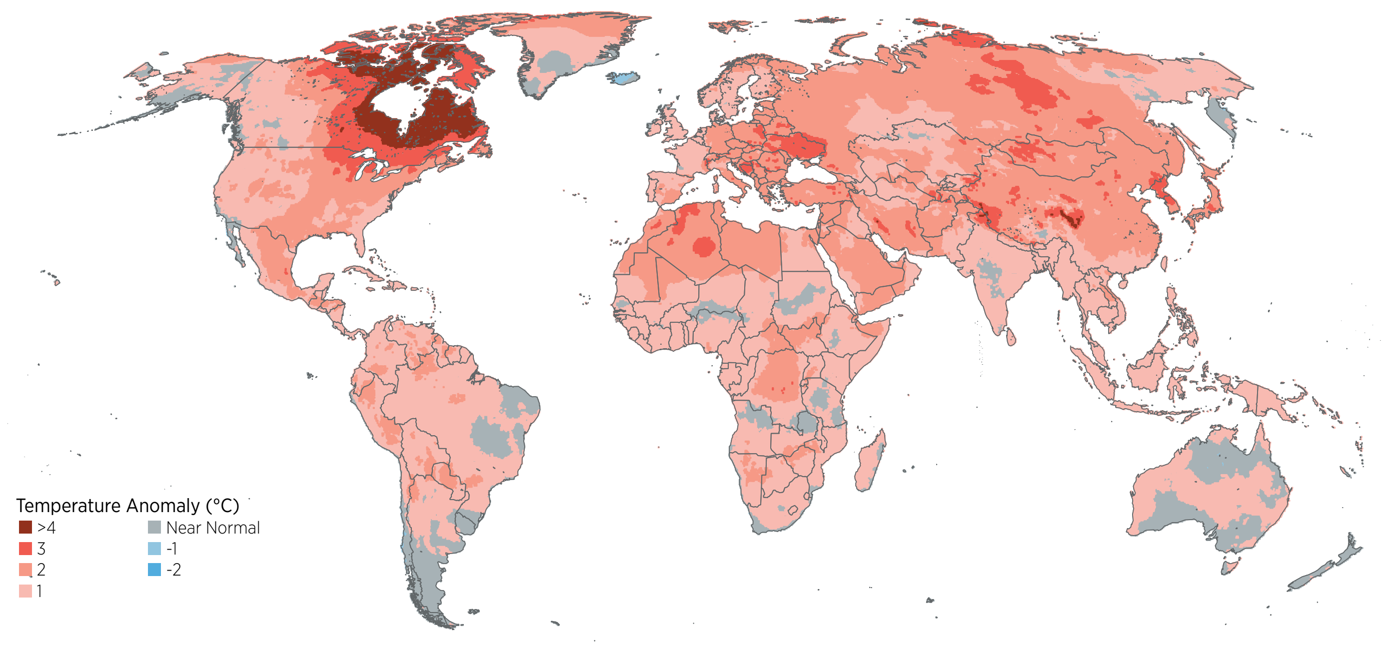


Figure 16: 2024 global temperature anomalies compared to the 1991-2020 climatological normal | **Data:** Copernicus (ERA5) | **Graphic:** Gallagher Re

Unsurprisingly there was much more variability in global precipitation patterns. These patterns were influenced by multiple drivers such as seasonal climate oscillations, blocked or stationary highs and lows, jet stream dynamics, monsoonal troughs, and moisture enhancement from near to record-warm oceans.

One of the more notable regions to face widespread rainfall deficits was South America. These deficits entered a second year and parts of the La Plata and Amazon basin(s) endured major drought conditions which enhanced the spread of brushfires and wildfires. This resulted in billions (USD) of direct economic damage or loss to the agribusiness sector as crops were decimated and major rivers saw anomalously low flow rates. Similar conditions were seen in central and northern Mexico, where drought and a lack of drinking water led to dire circumstances in many cities. Elsewhere in the Americas, despite historic levels of rainfall from tropical cyclones in the US, many parts of the country saw long periods without precipitation in Q2 and Q3 which lead to considerable impacts on crop yields. In southern California, a record dry spell persisted throughout the second half of the year.

The situation likewise remained critical for drought conditions in parts of Central and Eastern Europe. Agricultural lands were especially impacted in several Mediterranean countries (Romania, Bulgaria, Greece, etc.). Conversely, prolific rains affected other parts of the European continent in 2024 that spawned historic floods and generated widespread damage. This was seen in major flooding events in parts of Germany, Central and Eastern Europe, and Spain, all resulting from cut-off lows or blocked weather patterns. Belgium recorded its wettest year on record, beating the previous record set in 2001. Data records in Belgium began in 1833.

Shifting to Asia Pacific, parts of Southeast and Northeast China experienced an active summer flood season from late April and August. South Asia likewise had a wet year, with above-average monsoonal rainfall in Pakistan (+51%), India (+8%), and Nepal (+22%). Multiple tropical cyclones and their remnants, aided by enhanced moisture from the Southwest Monsoon, led to widespread flooding in portions of Taiwan, northern Philippines, and Vietnam. Elsewhere, the heaviest rains since 1900 led to flooding in parts of Australia's central Northern Territory, a sparsely populated area.

Figure 17 visualizes precipitation anomalies in 2024. The green colors indicate higher than normal precipitation, and shades of brown showcase less than normal precipitation. Note that this aggregated data can be misleading as record-setting rainfall events can obscure rapid swings from drought to flooding. The 'whiplash' from one weather extreme to another is becoming more common. The 'compounded' or 'connected' implications of multiple perils are leading to more regular enhanced impacts.

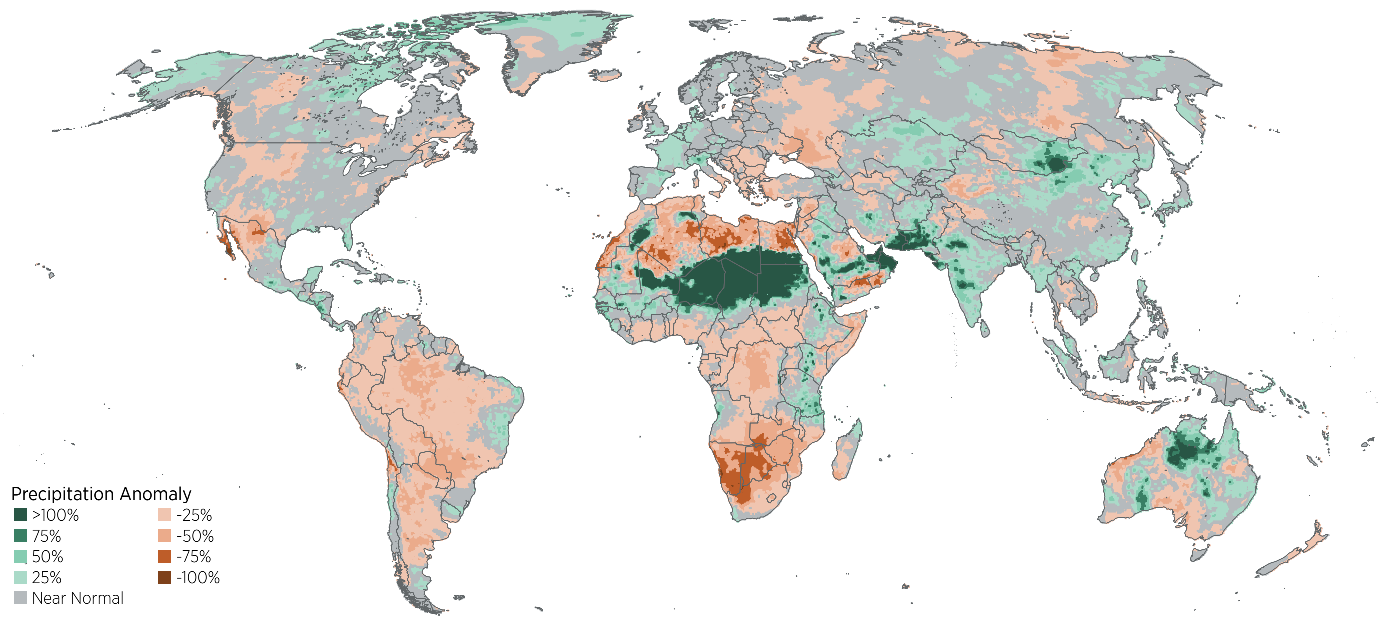


Figure 17: 2024 global precipitation anomalies compared to the 1991–2020 climatological normal | **Data:** Copernicus (ERA5) | **Graphic:** Gallagher Re

Global tropical cyclone review

Calendar year tropical cyclone activity in 2024 was below average based on every major metric: named storms, hurricane or hurricane equivalent, major hurricane (Category 3+), and Accumulated Cyclone Energy (ACE). The season was influenced by fading El Niño conditions that later transitioned towards ENSO-neutral and weak La Niña-like conditions by the end of the year.

Basin	Named Storms	Hurricanes	Major Hurricanes (Cat 3+)	Accumulated Cyclone Energy (ACE)
North Atlantic	18 (14.4)	11 (7.2)	5 (3.2)	161.6 (122.5)
Eastern North Pacific	13 (16.6)	5 (8.8)	3 (4.6)	82.5 (132.7)
Western North Pacific	23 (25.4)	15 (15.9)	9 (9.2)	203.9 (299.6)
North Indian	4 (5.3)	1 (2.1)	0 (1.0)	7.4 (24.3)
Northern Hemisphere	58 (61.7)	32 (34.0)	17 (18.0)	455.4 (579.1)
South Indian	20 (16.3)	9 (9.0)	6 (5.1)	150.4 (136.8)
South Pacific	8 (9.5)	1 (4.6)	0 (2.5)	16.0 (69.9)
Southern Hemisphere	28 (25.8)	10 (13.6)	6 (7.6)	166.4 (206.7)
Global	**86 (87.5)**	**42 (47.6)**	**23 (25.6)**	**621.8 (785.8)**

Table 6: 2024 calendar tropical cyclone statistics by basin compared to 1991-2020 climatology | **Data:** NOAA (NHC) and the Joint Typhoon Warning Center (JTWC)

Tropical cyclone tracks resulted in several significant landfalls around the world, as seen in **Figure 18**. On a global basis, tropical cyclones caused USD161 billion in economic loss, which was the third-costliest year on record behind 2017 (USD400 billion) and 2005 (USD311 billion). The USD51 billion covered by the private insurance market and public insurance entities was fifth on record, only behind 2005 (USD144 billion), 2017 (USD126 billion), 2022 (USD64 billion), and 2004 (USD57 billion). The Atlantic basin led with the highest economic (USD130 billion) and insured (USD49 billion) loss totals. Both totals were substantially above recent average(s) for the basin. The Western Pacific was second with economic costs at USD22 billion. Approximately USD2 billion was covered by insurance. The other basins (Eastern Pacific, Southern Pacific, North Indian, and South Indian) combined to result in USD8 billion in economic losses; with less than USD900 million covered by insurance. Elevated loss totals in the South Indian basin were driven by Cyclone Chido.

Figure 18: Global tropical cyclone tracks in 2024; only points at named storm strength | **Data:** NOAA (IBTrACS) | **Graphic:** Gallagher Re

Note: For this analysis, historical actual incurred loss costs are adjusted to today's values. This is a separate type of analysis from normalization, which attempts to account for today's exposure and wealth. To view a recent paper accounting for normalized historical Atlantic hurricanes, please click here.

NORTH ATLANTIC

It may not have set financial records, but the 2024 Atlantic hurricane season was very memorable across parts of the US Southeast and Appalachia following exceptional impacts from major hurricanes Helene and Milton. The two storms combined resulted in at least USD113 billion in economic losses. The basin-wide annual economic toll was USD130 billion, ranking as the fourth costliest season on record following 2017, 2005, and 2022. Private and public insurers covered USD49 billion of the total - also the fourth costliest on record, as seen in **Figure 19**.

Despite an extended lull in tropical activity during the peak season in August and September, the season concluded with an above average 18 named storms, of which 11 obtained hurricane status, and five became major hurricanes (Category 3+). The seasonal Accumulated Cyclone Energy (ACE), a metric that account for the intensity and duration of named storms, was 162. This was well above the long-term average of 123 and qualified as an extremely active or hyperactive hurricane season. The season saw 12 named storms come ashore, including five US mainland hurricane landfalls (Beryl, Debby, Francine, Helene, and Milton); the second-highest number of US hurricane landfalls on record. Helene (Category 4) and Milton (Category 3) each struck as major hurricanes.

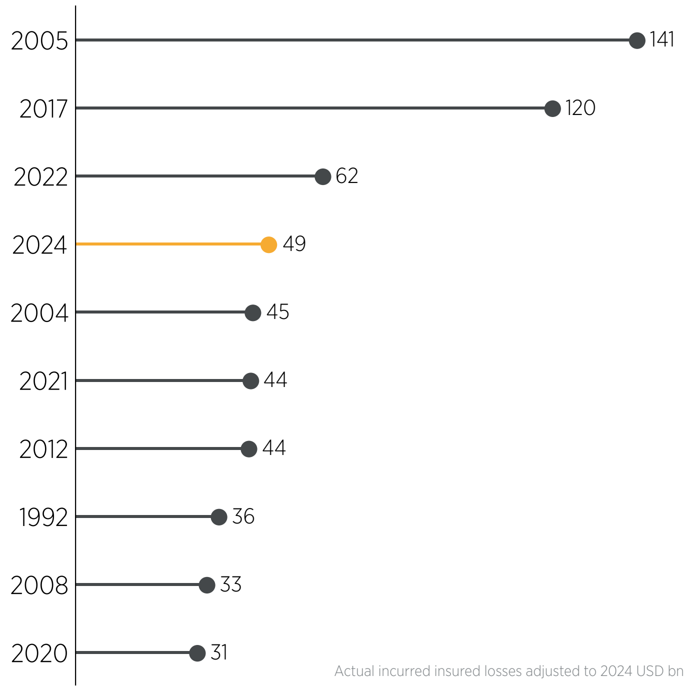


Figure 19: Costliest Atlantic hurricane seasons by insured loss in today's dollars
Loss Data & Graphic: Gallagher Re

Helene

Hurricane Helene came ashore as a Category 4 storm in Florida's Big Bend region on September 26, just miles from where Hurricane Debby (Category 1) came ashore in early August. Helene brought hurricane and tropical storm force wind gusts well inland across Florida, Georgia, and the Carolinas. This resulted in multi-billion-dollar wind driven property and agricultural losses far from the coast. The storm was most memorable for driving unprecedented flooding across Appalachia, particularly the Carolinas and Tennessee. The flooding prompted a humanitarian crisis and isolated many towns. Multi-day rescue operations were carried out by air as local infrastructure and roadways were significantly damaged or destroyed. Entire neighborhoods were washed away.

Helene ranks as one of the deadliest US hurricanes in the modern era, directly resulting in at least 219 fatalities. The hardest hit region in western North Carolina received 20 to 30+ inches (500 to 760+ millimeters) of rainfall. This corresponded to a greater than a one-in-1,000-year return period total (less than 0.1% chance of occurring in any given year). Data from the National Flood Insurance Program (NFIP) indicated that public flood losses from Helene were likely to approach USD7 billion. The storm reinforced the importance of regularly updating flood maps and understanding changing flood risks amid a warming climate. This ensures homeowners can more fully evaluate the risks associated with the peril. Total public and private insured losses were likely to exceed USD20 billion. The overall economic loss was substantially higher at USD78 billion.

Milton

Hurricane Milton made a Category 3 landfall in Sarasota County, Florida on October 9. While a worst-case scenario was avoided with landfall just south of Tampa, which spared major storm surge for the densely populated metro region, Milton brought hurricane force winds, flooding rains, and coastal inundation to much of southwestern Florida. Milton's impacts were less than feared as the system, which already had a small wind field, started to decay as it came inland near Sarasota. Only a limited part of west-central Florida recorded hurricane-force winds, which helped limit the number of filed claims. It did initiate a record-breaking tornado outbreak in Florida. Public and private insured losses from Milton were expected to approach USD20 billion. The overall economic loss was USD35 billion.

West-central Florida has carried lots of luck by avoiding major hurricane landfalls in the last 100+ years. With an aging housing stock in many coastal counties (notably Pinellas), the potential for major impacts from wind and storm surge is high. Many homes in the hardest-hit counties from Milton were built prior to post-Andrew building code updates enacted in 1995.

EASTERN PACIFIC

The Eastern Pacific basin saw a rather quiet season featuring a below average 13 named storms and 5 hurricanes, of which three reached major hurricane status (Category 3+). This was in comparison with the climatological mean (1991-2020) of five major hurricanes. The seasonal Accumulated Cyclone Energy (ACE) was 82, below the long-term average of 133.

No named storms formed through the month of June, with Tropical Storm Aletta becoming the first named storm on July 4. Aletta was the latest first storm formation for the basin in the satellite era (1966-present). Tropical Storm Ileana and Hurricane John were the only storms to make landfall, both in September. After a period of rapid intensification, Hurricane John made landfall in Mexico's Guerrero State on September 23 as a Category 3 storm. John later re-formed just off the Mexican coast bringing additional rounds of heavy rains to Guerrero, Oaxaca, Chiapas, and Michoacan. John inundated Acapulco and surrounding communities with more than 37 inches (950 millimeters) of rainfall. Local government officials estimated the economic flooding damage in Acapulco alone to have exceeded USD2.4 billion. This came just under a year after Hurricane Otis made a devastating landfall in Acapulco in October 2023 at Category 5 intensity. Otis caused USD15.5 billion in economic damage (in today's dollars).

WESTERN NORTH PACIFIC

The Western North Pacific basin endured its fifth-latest start to the season once Ewiniar developed on May 25, which was surprising since lingering El Niño conditions were present. The Pacific Ocean typically sees higher activity during an El Niño (warmer ocean waters) and fewer storms during La Niña (cooler ocean waters). The 2024 season later picked-up in activity and finished with 23 named storms. This was below the climatological average (1991-2020) of 25.4. The total continued a five-year streak of below-average tropical cyclone activity dating to 2020. By the middle and latter portion of the calendar year, ENSO-neutral conditions prevailed. Of the 23 named storms noted by the Joint Typhoon Warning Center (JTWC), 15 strengthened into hurricane-equivalent typhoons. This is slightly less than the seasonal average of 15.9. One active stretch had four simultaneous typhoons in the basin for the first time during the month of November since reliable meteorological records began in 1950.

Several agencies track tropical cyclones in the Western Pacific, including the JTWC, Japan's Regional Specialized Meteorological Center (RSMC), and the Philippine Atmospheric, Geophysical, and Astronomical Services Administration (PAGASA) with slightly different recording metrics. The RSMC, which provides a 10-minute average of maximum sustained wind speeds, noted 26 named storms. For reference, the JTWC uses a 1-minute wind speed average. The Philippines recorded at least 18 named storms or depressions that traversed the Philippine Area of Responsibility (PAR). Ten of those storms officially made landfall in the country.

The most significant typhoon of the season, covered in more detail elsewhere in this report, was Typhoon Yagi. The storm and its remnants, which resulted in an economic cost approaching USD17 billion, left catastrophic impacts in parts of South China's Hainan, northern Vietnam, Laos, Thailand, and Myanmar. Nearly 850 people died. The only other billion-dollar economic loss in the basin was Gaemi (China, Philippines, Taiwan). In total, the economic loss from the Western North Pacific basin was USD22 billion. Only USD2 billion was covered by insurance.

NORTH INDIAN

The North Indian basin saw four named storms (Remal, Asna, Dana, and Fengal) in 2024, which was below the climatological average of five. The strongest system was Severe Cyclonic Storm Dana. Cyclone Asna was the only named storm that made landfall in West India. Multiple additional storms deemed depressions by the India Meteorological Department (IMD) brought heavy rains and flooding to India. Total damage costs from the season were listed at more than a billion (USD). Tropical cyclone activity in the North Indian is bimodal, peaking during the post-monsoon season of October to November, and pre-monsoon season from April to May.

SOUTHERN HEMISPHERE

2024's most significant tropical cyclone activity in the Southern Hemisphere came in the South Indian basin. Cyclone Chido affected Mayotte, Madagascar, Mozambique, and Malawi in December. The storm resulted in catastrophic damage in Mayotte, with insured losses exceeding USD75 million. It marked one of the costliest cyclone losses for insurers in the basin on record. Other notable South Indian storms and economic losses included Belal (Mauritius; USD275 million), Hidaya (Tanzania; USD185 million), and Gamane (Madagascar; USD75 million).

Australia and other island nations in Oceania enjoyed a relatively benign year. The Australian Reinsurance Pool Corporation (ARPC) incurred USD97 million in claims costs for the 2023/2024 cyclone season. Most losses were tied to Jasper (2023; USD57 million) and Kirrily (2024; USD39 million).

El Niño-Southern Oscillation (ENSO)

The strong 2023-24 El Niño event, which began in mid-2023, dissipated into ENSO-neutral conditions by May 2024. The 2023-24 event ranked as the fifth strongest in recorded history. The positive feedback loop of El Niño on global temperatures aided in 2024 being the warmest year on record.

The El Niño-Southern Oscillation (ENSO) is an oceanic-atmospheric oscillation which occurs in the tropical Pacific Ocean. ENSO is important due to is global influences on seasonal temperature and weather patterns. The coupled nature of ENSO means that atmospheric circulations in tandem with sea-surface temperatures (SST) are components in defining El Niño and La Niña episodes. While models forecast that La Niña conditions (the cool phase of ENSO) would be present by Q3 2024, SST anomalies in the tropical Pacific's Niño-3.4 region (170°W to 120°W and 5°S to -5°N) stalled in May. However, the atmosphere began to resemble a La Niña-like state during 2024. This manifested in suppressed rainfall near the international date line, stronger circulation patterns across the equatorial Pacific, and affected tropical cyclone activity. There are multiple indices used to measure ENSO, and the following section highlights three commonly used metrics.

OCEANIC NIÑO INDEX (ONI)

The traditional Oceanic Niño Index (ONI) calculates ENSO by comparing SSTs in the Niño-3.4 region to the historical average. The average is calculated from the most recent 30-year climatology, currently 1991-2020. To be considered La Niña, the three-month ONI needs to reach -0.5°C (+0.5°C for El Niño). Despite an atmosphere that resembled what is expected during a La Niña phase, the latest ONI anomaly remained cool, at -0.24°C, but not yet cool enough to declare La Niña. The official ONI forecast favors the development of a weak La Niña during the first half of 2025.

RELATIVE OCEANIC NIÑO INDEX (RONI)

The relative-ONI (RONI) compares Niño-3.4 SSTs with the rest of the tropical oceans, which have exhibited near to record warmth in 2024. The relative-ONI is effective because changes in tropical rainfall and circulations are most sensitive to differences of temperature across the ocean's surface. In essence, even though the tropical Pacific may not be that cool in relation to the historical average, it remains cool relative to the rest of the tropics. The relative-ONI index has dipped below -0.5°C since the three-month period centered on July.

MULTIVARIATE ENSO INDEX (MEI)

The bi-monthly Multivariate ENSO Index (MEI) is a widely used metric, calculated by NOAA. The MEI tracks ENSO events based on both oceanic and meteorological factors (such as surface winds, sea level pressure, and outgoing radiation). The MEI bi-monthly average has dipped into La Niña territory since mid-2024.

Takeaways

As seen in **Figure 20**, historically the three indices have given similar results. While further research is needed, recent months have shown why historical SSTs via the ONI may not always be the most efficient use case to determine ENSO conditions in the current climate. Despite La Niña not officially being declared in 2024 by NOAA or other international agencies, there were clear La Niña-like weather patterns already in place which the RONI and MEI indices identified. While no two La Niña cycles are alike, these conditions are historically associated with amplified regional extremes of temperature and precipitation — which were seen in the second half of 2024.

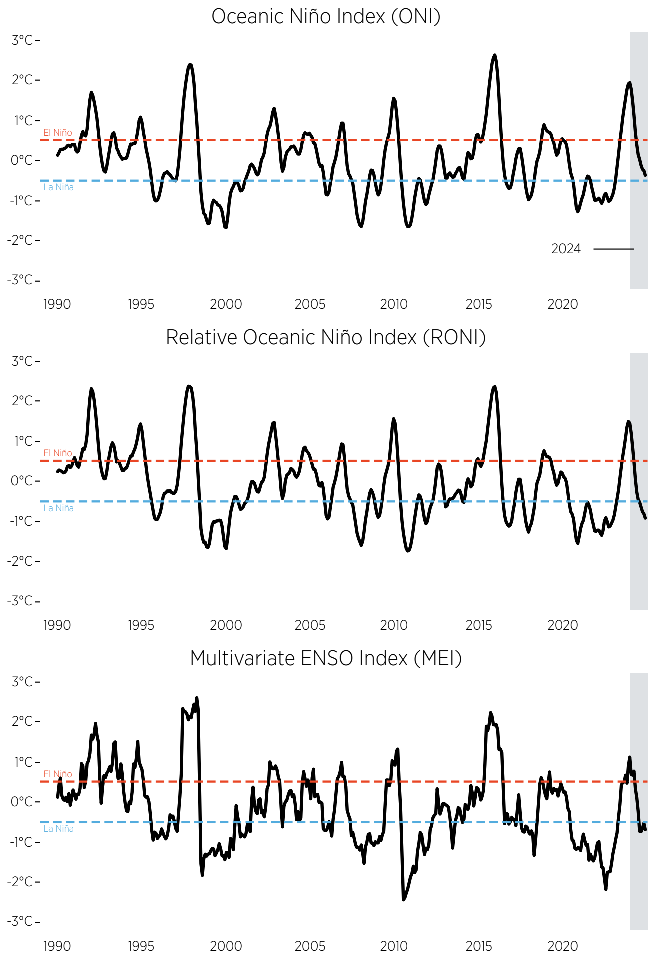


Figure 20: ENSO Index Comparison: ONI v RONI v MEI (1990-2024)
Data: NOAA/PSL | **Graphic:** Gallagher Re

Antarctic and Arctic Sea Ice Extent

Several days during 2024 saw the lowest daily sea ice extents in the 46-year modern satellite era (dating back to 1979). For the whole calendar year, the Antarctic continued to see exceptionally low levels of sea ice formation during the Southern Hemisphere summer and winter months. Trends marked a continuation from what was experienced in 2023 when sea ice extent reduced at rates not seen in modern history. Minimum extent coverage in the Antarctic for 2024 ended as the second lowest behind 2023 with an annual minimum extent of 1.99 million km^2 (768,000 mi^2) on February 20. An annual maximum extent of 17.16 million km^2 (6.63 million mi^2) occurred on September 19. However, the National Snow and Ice Data Center (NSIDC) cautioned uncertainty due to an outage in the input source data between September 12-18.

In the Arctic, sea ice bottomed out at 4.28 million km^2 (1.65 million mi^2) on September 11, the seventh lowest on record. An area roughly the size of Alaska was lost when compared to the 1981-2010 climatological average. Much of the ice in the Arctic is now estimated to be less than four years old and remains relatively thin, which allows more heat to escape into the atmosphere. Sea ice extent in the Northwest Passage, a sea lane between the Atlantic and Pacific Oceans through the Canadian Archipelago, was at its lowest on record during the Northern Hemisphere summer months. This was aided by high-pressure systems which drove warm winds northwards.

A group of scientists in October 2024 advised the Nordic Council that a possible faster-than-expected weakening of the Atlantic Meridional Overturning Circulation (AMOC) may occur. The AMOC is a major ocean current system that transports warmer waters to the Arctic, and cooler waters toward the equator. At a certain tipping point, this heat transfer and carbon sink could collapse, which would bring devastating and potentially irreversible impacts such as sea level rise and more volatile weather patterns. The updated findings presented to the Nordic Council incorporated new ice-melt data and revealed the need for increased decarbonization to prevent catastrophic tipping points.

The cryosphere is essential to the broader regulation of Earth's climate, including global weather patterns and ocean circulations. Further thinning of sea ice coverage alters global albedo (reflected light) and compounds sea ice loss as an expanding ocean surface absorbs incoming solar energy and reinforces increases in temperature. An increase in ocean heat content inevitably increases the volume of water in the ocean.

Such topics are very important for the insurance industry and require close attention as the continued accumulation of risks from sea level rise, especially in areas where the observed and predicted rates are moving ahead of the global average. Meaningful adaptation and mitigation measures such as nature-based solutions from governing bodies would be needed to aid in lowering the overall risk (and price) to society.

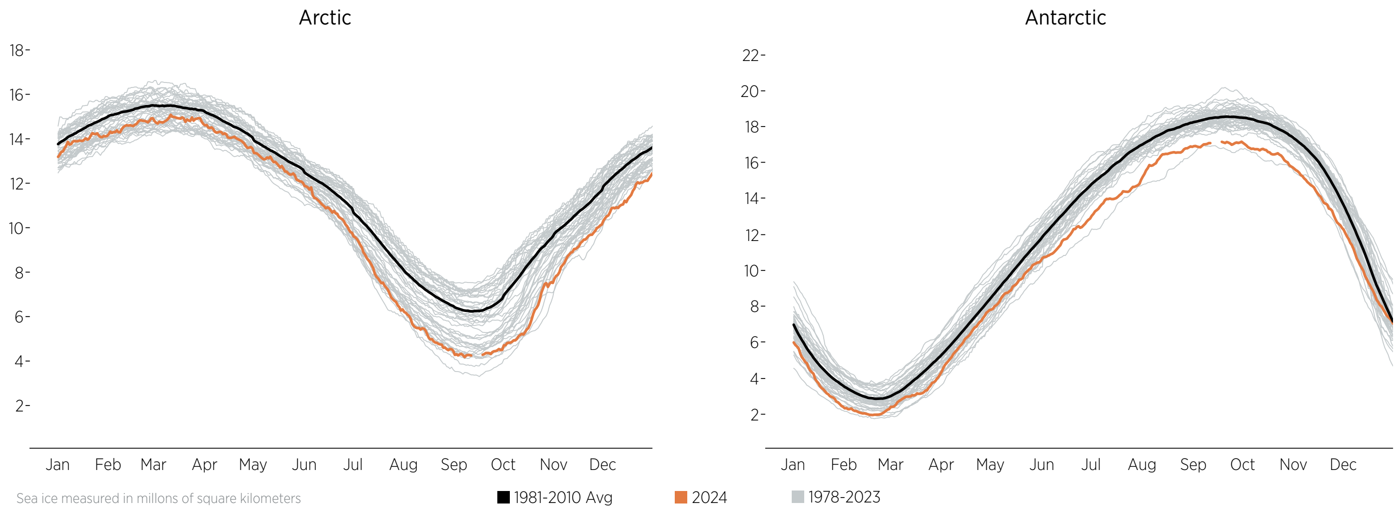


Figure 21: Sea ice extents (millions of square kilometers) in the Arctic and Antarctic (1978-2024) | **Data:** NSIDC | **Graphic:** Gallagher Re

Global sea level rise

Sea level rise is caused primarily by two factors related to global warming: the added water from melting ice sheets and glaciers as alluded to above, and the thermal expansion of seawater as it warms. Official observational records extend to 1880, where tidal gauge data was implemented on an annual basis through 1992. Starting in 1993, the arrival of satellite instrumentation allowed for monthly observations to begin. The data confirms that there has been a notable acceleration in overall global sea level rise since starting from an 1880 baseline. From 1880 to 1950, the sea level rise trend was approximately 1.2 millimeters per year. That has accelerated to a rise of approximately 3.6 millimeters per year during the period from 2013 to 2024. Overall, the total accumulated global rise has been 10.2 inches (258 millimeters) since 1880. As sea levels rise, so does the increase in frequency of high-tide flooding (also known as "nuisance flooding" or "sunny day flooding"), which can heavily disrupt the livelihoods of those living in coastal communities. By 2030, high tide flooding is likely to be about two to three times greater (seven to 15 days) in the US alone, according to NOAA.

In an unusual tidal event due to the combined effects of astronomical tides, storm surge oscillations flooded China's east coast in October, with water levels staying nearly one meter (39 inches) above the normal level for more than 20 hours. Similarly, North Jakarta, which has been plagued with land subsidence, experienced tidal flooding for at least five days in December. According to the World Meteorological Organization (WMO), sea levels in the Western Pacific have risen at nearly twice the global rate measured since 1993, especially putting low-lying Pacific Islands at risk. High rates of sea level rise were also observed in the western Gulf of Mexico and southern US. For example, the sea level at the Fort Pulaski gauge has risen by more than seven inches (178 millimeters) since 2010, among the fastest rates in the country.

There are several climate and non-climate related factors driving sea level rise. Most notably, the melting of glaciers and the thermal expansion of water as the oceans warm. Additional factors such as land subsidence, bathymetry, shifts in land motion due to earthquakes or volcanoes, and land-water storage also influence the rates of sea level rise. Notably, sea level rise is not globally linear nor consistent, and some regions of the globe are seeing faster rise than others. Some regions have seen slight declines.

Sea level can further be influenced by seasonal climate oscillations, such as ENSO. Most climate scenarios in IPCC's Sixth Assessment Report (AR6) suggest a sea level rise of 500 millimeters (19.7 inches) by 2100 compared to the 1995-2014 baseline. The chronic nature of coastal flooding should be a primary point of emphasis to prompt federal and regional governments to invest in ample coastal flood defenses.

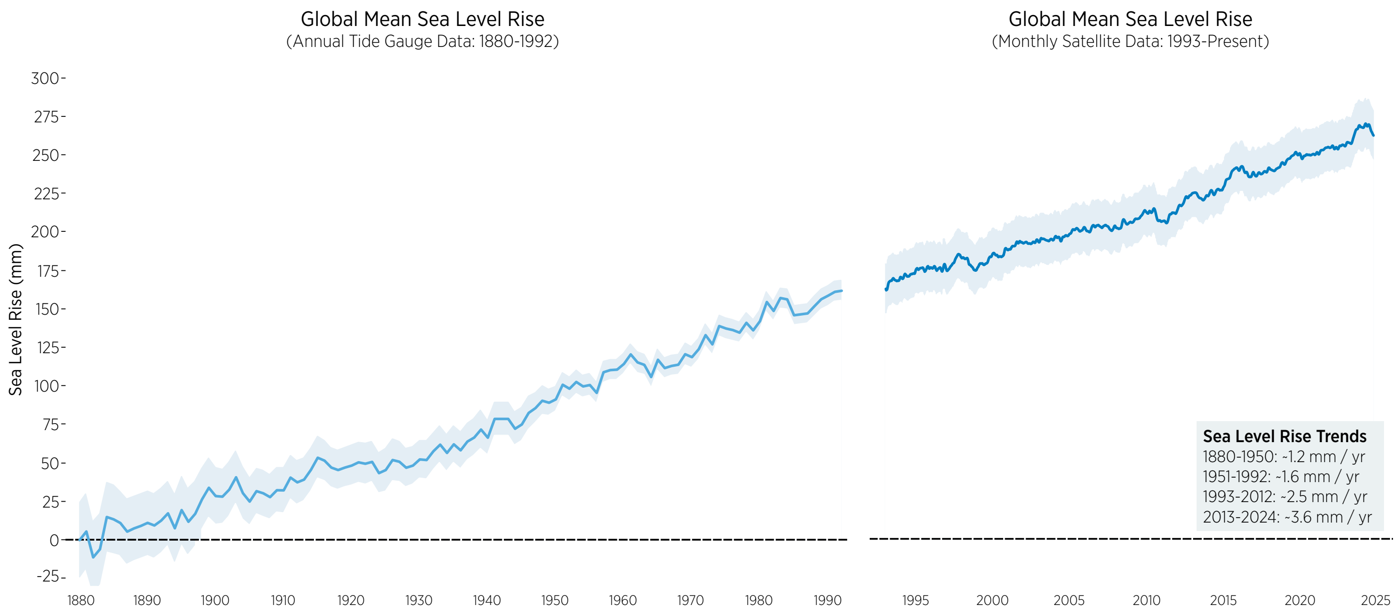


Figure 22: Global sea level rise since 1880 | **Data:** NOAA/NASA | **Graphic:** Gallagher Re

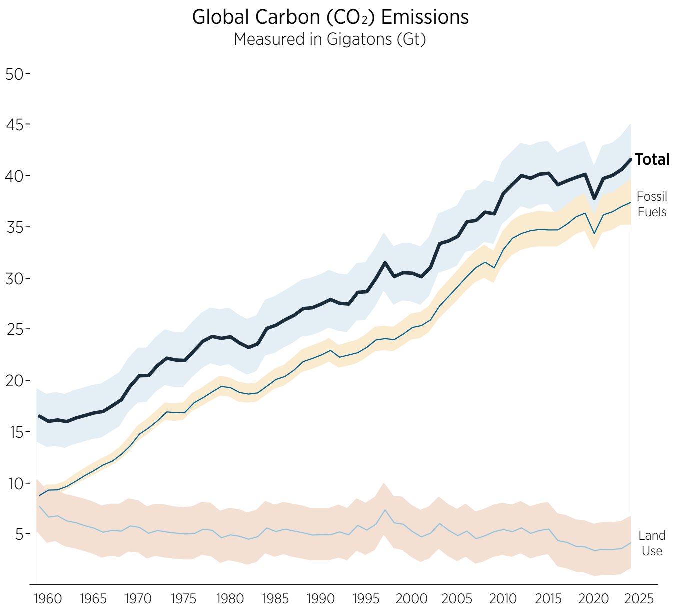
Global greenhouse gas emissions

Federal governments and private companies have made ambitious and essential net-zero commitments to dramatically reduce global carbon footprints. This comes at a time when total global carbon dioxide (CO2) emissions were projected to reach 41.6 gigatons (Gt) in 2024; up from 40.6 Gt in 2023. The vast majority (37.4 Gt) is attributed to fossil fuel emissions and the rest from land-use changes, according to the Global Carbon Budget project. Fossil fuel CO2 emissions represent an increase of 0.8% from 2023 levels (36.8 Gt), while land-use CO2 emissions also rose as drought conditions exacerbated emissions from deforestation during El Niño in 2023-2024.

The two largest contributors of greenhouse gases came from the power (electricity generation) and transport sectors. Increases from international aviation have slowed compared to 2023 but are still rebounding from COVID-19 levels. Emissions from the power sector may soon peak as most of the new global energy demand is being replaced with renewable sources. Government policies pushing other sectoral transformations will also help to lower or reverse the year-on-year increase in CO2 emissions.

On the regional level, seven G20 members have yet to reach their peak emissions, defined as the maximum emissions at least five years before the year for which the latest inventory data becomes available (China, India, Indonesia, Mexico, Saudi Arabia, South Korea, and Turkey), but have Nationally Determined Contributions (NDCs) to work towards the goal. The current NDC version 2.0, based off 2019 levels, are in effect through 2030. The new round of NDCs, deemed 3.0, is due early 2025 and will outline countries' climate actions through 2035. Two G20 countries at COP29 (Brazil and the United Kingdom) signaled plans to ramp up climate action.

As a direct consequence of the increase in total carbon dioxide (CO2) emissions, atmospheric CO2 concentration reached a new weekly high of 427.9 ppm during 2024 in the week beginning April 21. A record daily high of 428.6 ppm was set on April 26, based on observations taken at the Mauna Loa Observatory in Hawaii. CO2 concentrations usually peak in spring and decline throughout the late summer (due to plant growth in the Northern Hemisphere). Monthly average CO2 concentration remained at or above 422 ppm throughout the year for the first time in millions of years. Once emitted, atmospheric CO2 and other greenhouse gases may take years, decades, or centuries to leave the atmosphere. This means that even with emission reductions there will be a lengthy lag until atmospheric concentration levels are reduced.



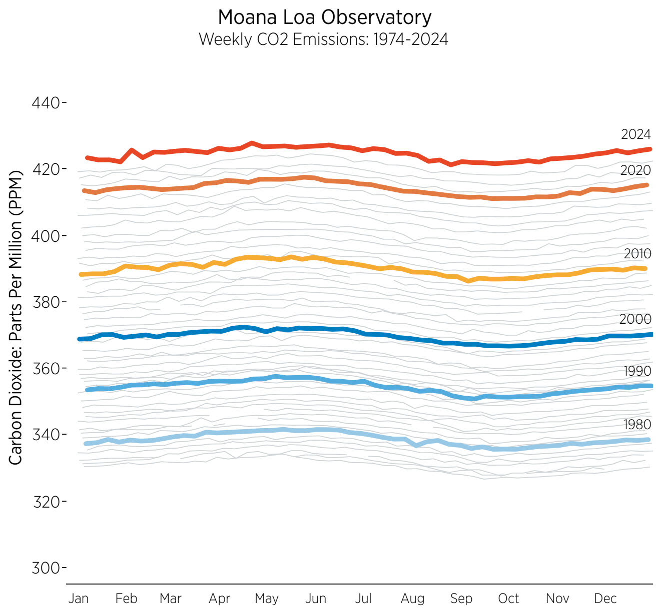


Figure 23: Global fossil CO2 emissions (Gt) and weekly atmospheric CO2 monitored at Moana Loa | **Data:** Global Carbon Budget & NOAA | **Graphic:** Gallagher Re

GUEST SECTION

The Critical Role of Public and Private Sector Relationships to Aid in Climate Financing

Antoine Bavandi

Climate change and its impact on people and livelihoods continue their worrying trend and the diagnosis is stark. An estimated one in five people are thought to be malnourished, roughly ten of 15 climate-related human health indicators have reached new records, and more than 100 million people have been forcibly displaced because of climate and conflict. Inaction is not just making lives worse — it is making the world less stable and secure.

Climate finance front and center

Climate finance took center stage at COP29. This included continued progress on the 'Loss and Damage Fund' for the nation's most vulnerable to climate risk, and wide recognition of the value of disaster risk financing and insurance. Multilateral development banks committed to boosting their climate financing, and advanced economies tripled the annual New Collective Quantified Goal (NCQG) to USD300 billion. This aims to help developing countries address and adapt to climate change. While this number falls short of the necessary total and includes a combination of grants, loans and guarantees, it will begin to help mobilize private and other financing in the places where it is needed most.

Critical role for loss and damage fund

Whilst the above commitments will help to finance climate change adaptation, risk reduction and prevention efforts, there is also strong need for the scaling up of financing for extreme, residual, unavoidable risks — which are on the rise. We are very pleased to see the Loss and Damage Fund (established at COP27) is now operational, with financial commitments close to USD1 billion. This financing vehicle is meant to leverage the role of risk transfer in regions that need it the most. Risk pooling, public-private partnerships, parametric insurance and cat bonds are prime examples of efficient use of the private sector. And we expect sovereign risk transfer and (re)insurance to continue to benefit from those developments, through additional premium financing and accelerated uptake of (re)insurance in developing countries.

Looking ahead

In the face of the unprecedented damage caused by the climate crisis, the cost of inaction has never been more evident. As COP29 concluded, our attention shifted to COP30 in Brazil, which is set to be a pivotal moment in global climate diplomacy. The stakes are high as countries must submit by then their updated national climate targets for 2035, which are critical to ensure alignment with global targets. The challenge is big and requires all of us to act. For our part, Gallagher Re is actively supporting clients in both developed and developing countries to help strengthen climate resilience. Through public-private partnerships, parametric risk solutions and sovereign risk financing advisory, we are committed to fostering collaboration, sharing knowledge, and driving collective action in the most impactful way.

Antoine leads Gallagher Re's Public Sector, Parametric & Climate Resilience Solutions practice.

Regional Recaps

United States (US)

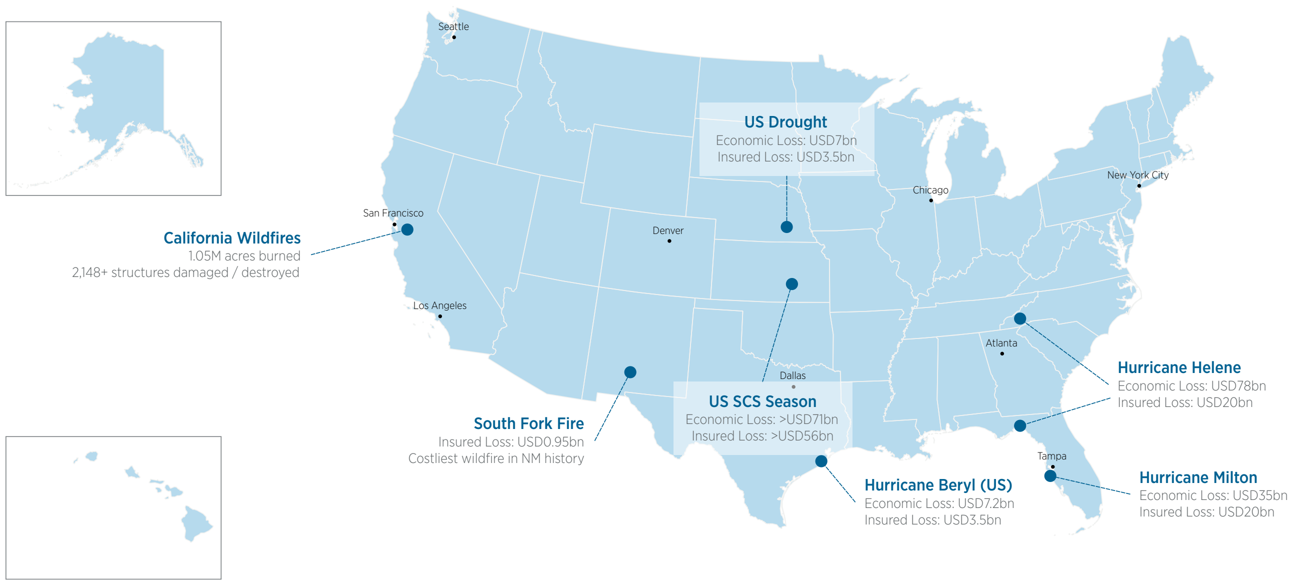
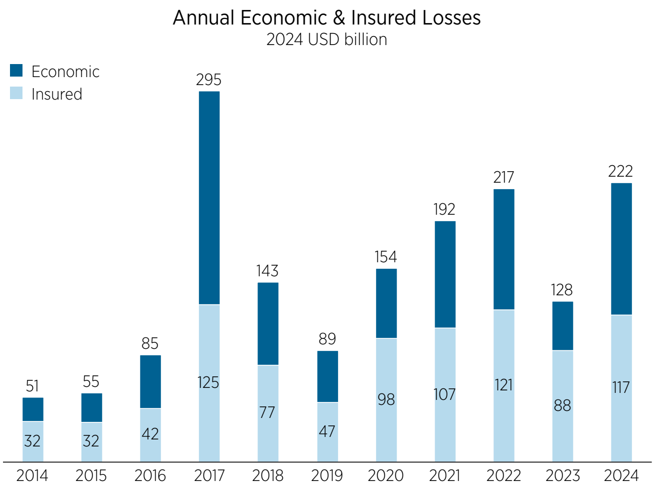
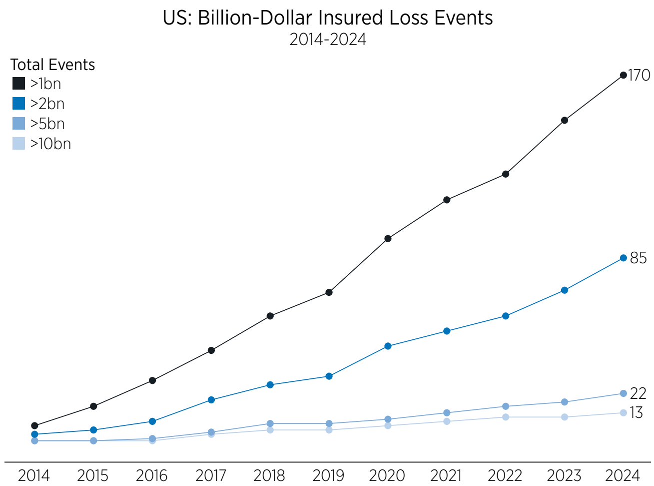


Figure 24: Map of notable United States events in 2024 | **Data & Graphic:** Gallagher Re





Notable Statistics: 2024

5
Number of US mainland hurricane landfalls in 2024; second-highest on record

29
Number of US SCS outbreaks with >USD500 million insured loss; second only to 2023 (33)

30.78
Peak rainfall total (in) from Helene recorded at Busick, NC; 781.8 mm

90 mph
Peak 24-hour intensification by Milton; only topped in the Atlantic Ocean by Wilma (110 mph) and Felix (100 mph)

Figure 25: United States natural catastrophe statistics in the past decade | **Data & Graphic:** Gallagher Re

United States: 2024 takeaways

- Third-highest count (829) of large hail reports (2+ inches) since 1990; major driver of the USD56 billion SCS insured loss total
- 32 individual billion-dollar economic loss events; 21 which also resulted in >USD1 billion in insured losses
- Hurricane Helene and Hurricane Milton generated USD113 billion in economic losses; USD40 billion covered by insurance
- 8.9 million acres of land burned from wildfires in 2024; major fire events recorded in California, New Mexico, and Texas
- The combination of record heat and a lack of precipitation drove the economic loss costs of drought to USD7 billion

The United States endured another active and costly year of natural catastrophe events in 2024. The insurance industry was impacted by the heightened frequency of severe convective storm (SCS) outbreaks in addition to multiple landfalling tropical cyclone events. The most expensive events were Hurricane Helene (USD20 billion) and Hurricane Milton (USD20 billion) which brought catastrophic impacts throughout the US Southeast. Three other hurricanes made US mainland landfalls: Beryl (Texas), Debby (Florida), and Francine (Louisiana). The economic cost from US tropical cyclones reached USD125 billion, with private and public insurers only covering USD46 billion of that total. Overall, the private insurance market and public insurance entities paid more than USD116 billion in claims for all perils. This was the fourth-costliest year on record behind 2005 (USD149 billion), 2017 (USD125 billion), and 2022 (USD121 billion). The USD100 billion threshold (on an inflation-adjusted basis) has been breached four times since 2017.

The two costliest US events were hurricanes, but the most expensive peril for the insurance industry was SCS. Hail continued to drive the bulk of damage costs even though 2024 saw well above-average tornadic activity, locally significant severe wind gusts, and flash flooding. SCS insured losses in 2024 exceeded USD56 billion and it became the second costliest year on record for the peril, only behind 2023 (USD64 billion). Only two other years outside of 2023 and 2024 have topped USD40 billion: 2020 (USD45 billion) and 2011 (USD41 billion).

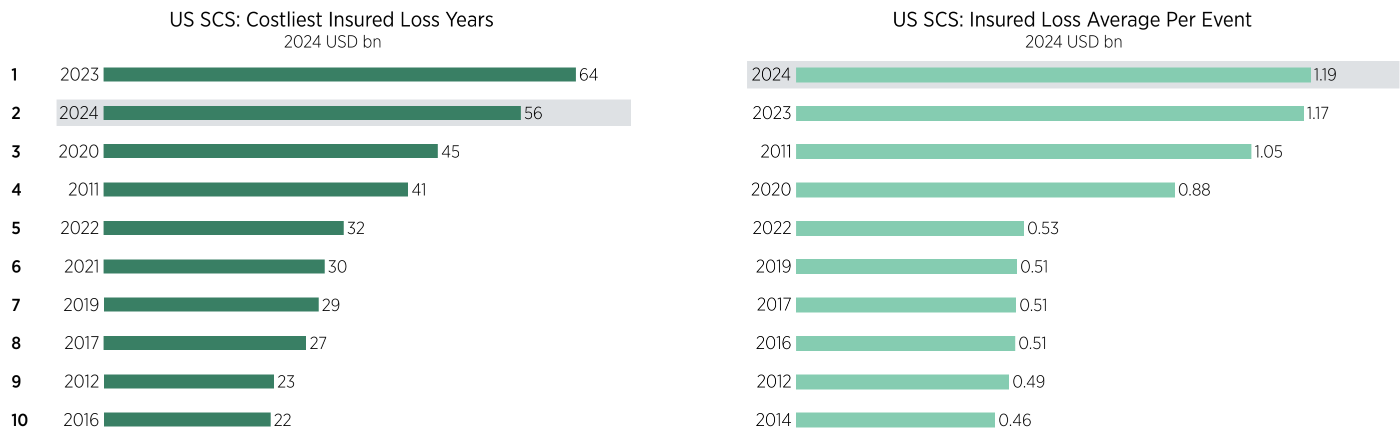


Figure 26: US SCS costliest insured loss years (left) and average loss per event (right) | **Data & Graphic:** Gallagher Re

US SCS: Second-costliest year on record

For the second year in a row, a prolific volume of costly and damaging SCS events led to considerable loss costs. The overall economic impact exceeded USD70 billion. Given high insurance take-up for the peril, insurers covered at least USD56 billion of that total. This was the US insurance industry's second-costliest year on record for SCS perils, only behind 2023. The two-year total for US SCS insured losses was a remarkable USD120 billion, without question the costliest two-year stretch ever recorded for the peril.

Following long-term trends, most of the losses were driven by the hail sub-peril, which typically accounts for 50% to 80% of SCS claims in any given year. The earlier 'In Focus' section of this report explores the scientific and socioeconomic factors driving US SCS losses in more detail. As stated, non-hazard drivers have accounted for 80 to 90% of the nominal loss growth since 2000.

Preliminary data from the Storm Prediction Center (SPC) indicated that 2024 was one of the most active years for tornadoes in the Doppler era (1990-present). At least 1,880 tornadoes were reported, of which 1,776 had been tentatively confirmed as of this publication. This ranks among the highest tornado counts on record alongside the memorable seasons of 2011 (1,691), 2008 (1,689), and 2004 (1,817). The month of May alone saw a record 527 confirmed tornadoes, more than double the 1991-2020 average. The most violent tornadoes during the year included 47 which were rated either EF3 (43) or EF4 (4). The EF4 tornadoes touched down in Nebraska, Iowa, and Oklahoma in April and May. The country has not officially recorded an EF5 tornado since May 2013 in Moore, Oklahoma, though this is likely an undercount since EF ratings are only given when physical damage is observed. A damaging tornado outbreak associated with Hurricane Milton which unfolded across Florida on October 9 prompted a daily state record of 46 confirmed tornadoes. This also exceeded the 15 tornadoes from Irma (2017) that was the previous record for Florida tornadoes due to a hurricane. At least three of the tornadoes were rated EF3. Overall, there were at least 27 deadly US tornadoes in 2024, accounting for 54 fatalities.

Throughout the year, at least 829 instances of large hail (2+ inches/5+ centimeters) were reported in the US. This tentatively ranks as the third most large hail reports on record, behind the anomalous 2023 and 2011 seasons. Lastly, wind reports in 2024 were notably above the long-term average. The costliest hail-driven SCS outbreak erupted across the central and eastern US in early May (6-10), generating public and private insured losses of USD5.5 billion. A multi-day early season outbreak in March (USD5.1 billion) was another highly costly and impactful event. 2011 is the only other year on record with two >USD5.0 billion insured SCS events.

Hail-driven losses throughout the season were most impactful across the Southern Plains, Southeast, and Rockies with costly events impacting highly populated regions near Dallas Fort Worth, Texas; Denver, Colorado; and Oklahoma City, Oklahoma; among other urbanized locations. In Texas, a June hailstone in Swisher County which was estimated to exceed 7.0 inches (17.8 centimeters) in diameter, will challenge the state record hailstone 6.4 inches (16.3 centimeters) that fell in Hondo in 2021.

Several damaging derecho events (long-lived windstorms) acted as a reminder of the risk that straight-line winds can pose, particularly when they impact heavily exposed regions. The May 16 Houston (Texas) derecho brought wind gusts up to 100 mph (160 kph) into densely populated neighborhoods of downtown Houston. Costly damage was incurred to residential and commercial properties, including several large skyscrapers. In mid-July, a pair of derecho events generated widespread damage across the Midwest, which included the densely populated Chicago, Illinois metro region.

Figure 27 highlights that large hail reports correlate with SCS insured losses at a statistically significant level. Damaging winds (non-tornadic) are also statistically significant, but not as strong as a correlation as large hail. Perhaps surprisingly, tornadoes (F/EF1+) show minimal correlation.

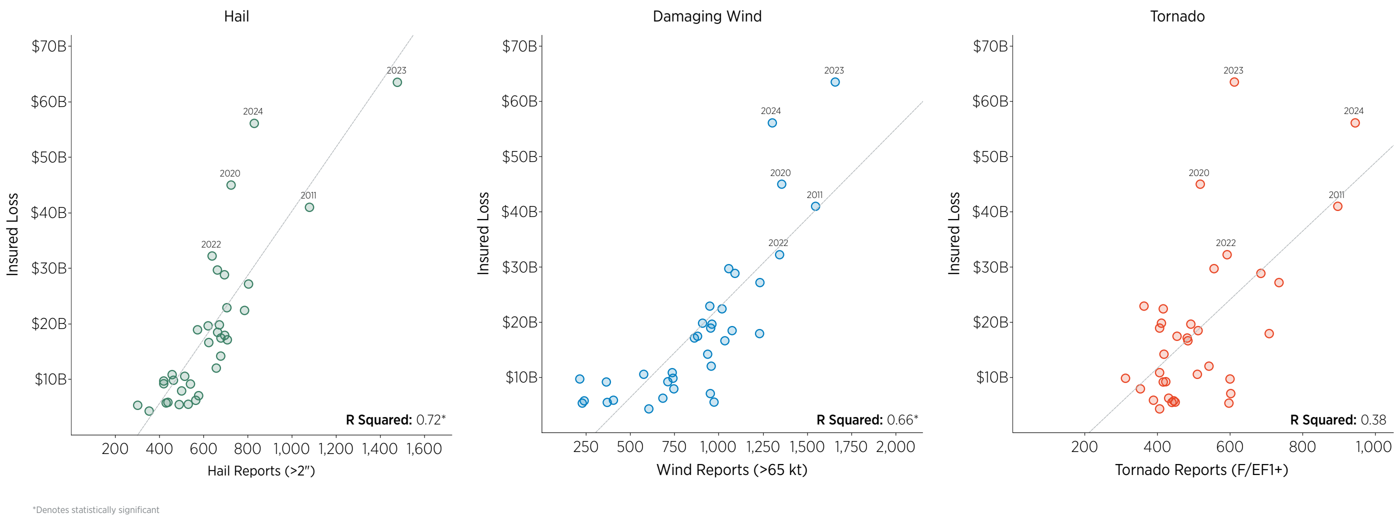


Figure 27: Correlation analysis between NOAA SPC storm reports by sub-peril and US SCS insured losses | **Storm Data:** NOAA | **Graphic & Analysis:** Gallagher Re

US wildfire

Anomalous heat and drought conditions set the stage for favorable ground conditions to amplify the rapid spread of any ignited wildfires. While 2024 was not a record year from a seasonal wildfire statistic or loss / impact perspective, it did result in notable events. Such events are becoming more plausible as a growing number of properties are constructed in the Wildland Urban Interface (WUI) or intermix, increasing the future potential for both costly and life-threating impacts. It should be noted that 2024 also became an important reminder that US wildfire risk is not solely limited to traditional fire prone areas in the West and that fire ignitions can occur during any month of the calendar year if conditions are right.

US insured wildfire losses topped USD2 billion in 2024. Fire events in New Mexico, California, and Texas drove the bulk of those losses. Overall, the US recorded 61,685 wildfires during the year, which affected an area of approximately 8.9 million acres (3.56 million hectares). This annual extent was above the 10-year average of nearly 7 million acres (2.83 million hectares).

The most significant wildfire event of the year occurred in New Mexico. The South Fork / Salt Creek fires destroyed at least 1,400 structures and resulted in an economic cost of USD1.75 billion. Slightly more than half was covered by insurance. The largest singular continental US fire was the Smokehouse Creek Fire that burned across the Texas Panhandle and parts of Oklahoma. That blaze charred 1.06 million acres (428,352 hectares) and destroyed more than 130 properties. A memorable November wildfire outbreak occurred in the Northeast following a historic autumn drought. Fires were ignited in New York, New Jersey, and Massachusetts. These large fires deteriorated air quality, burned through forested lands, and prompted evacuations.

California saw above-average activity with more than 1 million acres (404,685 hectares) burned, and at least 2,148 structures damaged or destroyed. July's Park Fire became the 4th largest fire in California state history, affecting at least 429,600 acres (173,850 hectares). A multi-day period of particularly dangerous fire weather affected drought stricken southern California in December. During this time the Franklin Fire impacted dozens of properties near Malibu.

GALLAGHER RE PRODUCT SOLUTIONS

US hail model

Gallagher Re has introduced an advanced hail model designed to assist customers in managing hail volatility from their personal and commercial portfolios. This innovative tool leverages extensive historical data and predictive analytics to provide insights into potential hail damage. By analyzing 24 years of high-resolution daily radar hail swath data, the model offers detailed risk assessments, including re-cast historical and expected loss, claim frequency, and severity for all locations across the US. This enables insurers to evaluate the impact of changes due to shifting deductible levels and geographic distributions, enhance rate adequacy, manage accumulations, determine new growth opportunities, and receive next-day event response loss estimates.

US wildfire hazard score

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.

Rest of the Americas: Canada / Latin America and Caribbean (LAC)

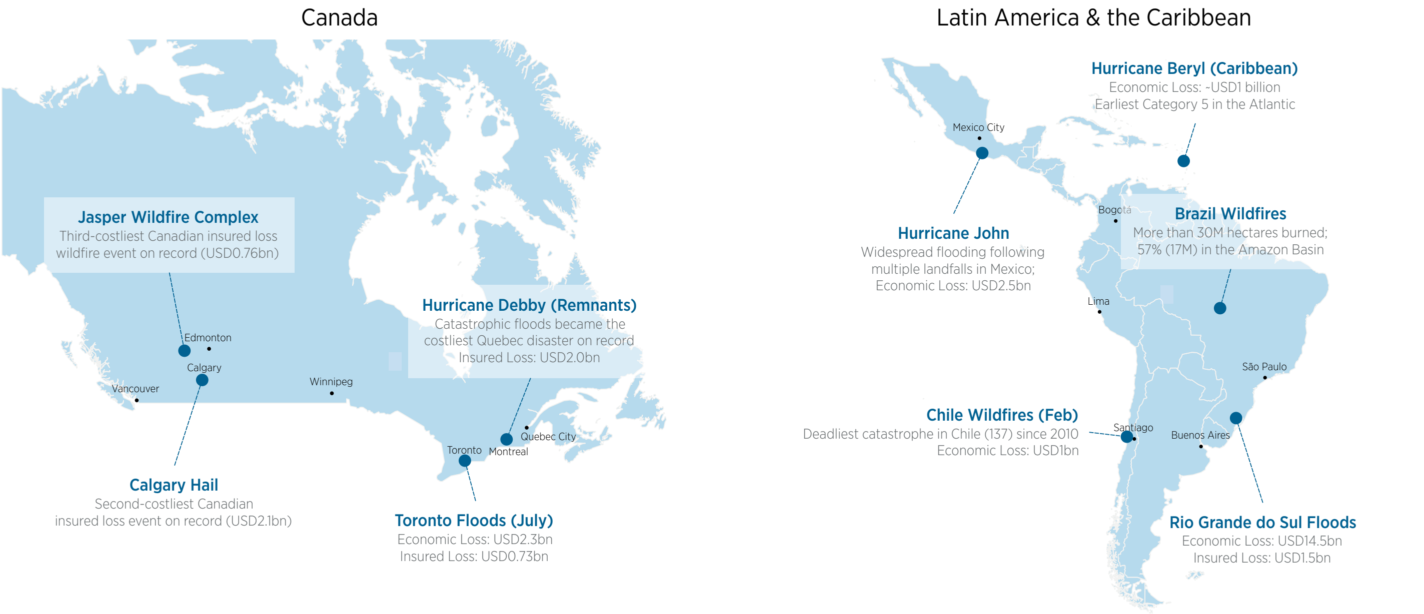
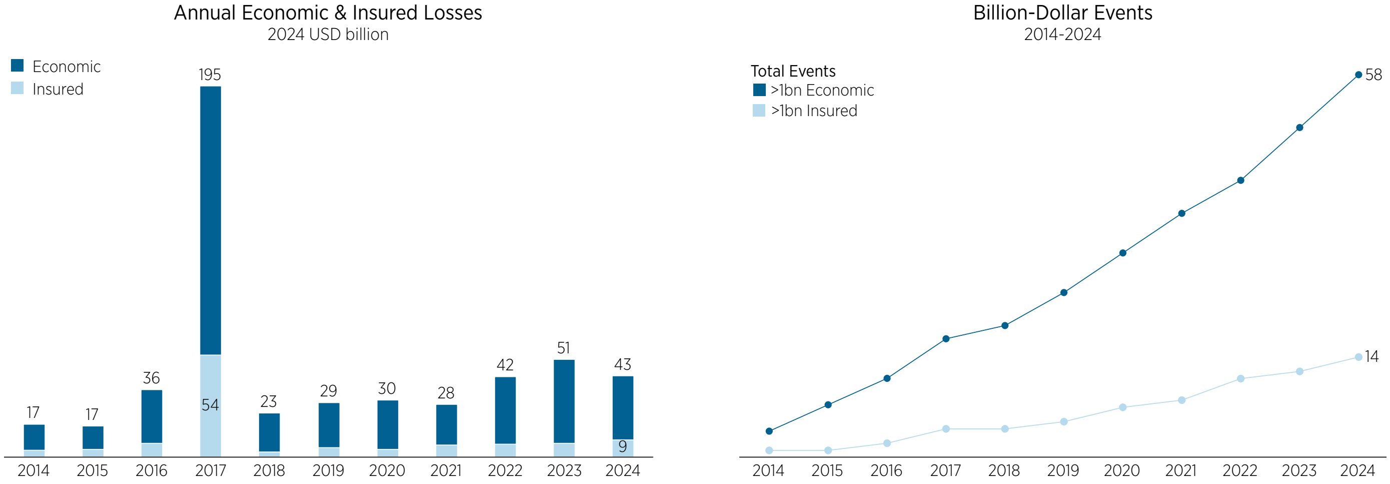


Figure 28: Map of notable Canada and Latin America & Caribbean events in 2024 | **Graphic & Data:** Gallagher Re



Notable Statistics: 2024

3.2M
Hectares of land submerged in Brazil's Rio Grande do Sul during April / May floods

120Mt
Record-setting carbon emissions in Bolivia from widespread wildfires fueled by drought

154
Highest 24-hour daily rainfall (mm) ever recorded in Montreal (6.06 in); August 9 from Debby's remnants

52°C
Hottest temperature ever reliably recorded in Mexico (Sonoran Desert); June 20 -- 125.6°F

Figure 29: Canada and Latin America & Caribbean natural catastrophe statistics in the past decade | **Graphic & Data:** Gallagher Re

Rest of the Americas: Takeaways

- Relentless stretch of summer flooding, SCS, and wildfire prompt record insured losses in Canada (USD6.2 billion)
- Extensive flooding in Brazil's Rio Grande do Sul incurred a USD14.5 billion economic toll
- Combination of record dry conditions and heat accelerate damaging wildfires across South America, including the Amazon
- Volatility in rainfall patterns exacerbate extreme drought conditions and spawn billions (USD) in damage across the Americas
- Parts of Latin America and Canada heavily affected by wind and flood impacts from hurricanes Beryl, Debby, John, and Sara

Financial loss costs across Canada and Latin America & the Caribbean (LAC) were elevated following extensive summer natural catastrophe activity. SCS, tropical cyclone, flooding, wildfire, and drought events were all recorded that had considerable impacts. Canada alone registered the costliest year for the local insurance industry on record with at least USD6.2 billion in payouts. The total overall economic cost from Canadian disasters neared USD12 billion.

LAC incurred economic losses that were close to average, compared to the past decade, but losses remained above the longer 21st century average. The most notable event was catastrophic flooding across southern Brazil's Rio Grande do Sul state. This resulted in one of Brazil's costliest insured loss events on record. Elsewhere, ENSO-influenced weather patterns brought excessive heat, drought, wildfires, and damaging floods across South America and Mexico. Several hurricanes traversed through the Caribbean. Hurricane Beryl was the most impactful, with nearly a dozen countries being affected. The aggregated economic cost topped USD1 billion. Storms Alberto, Debby, Ernesto, Helene, John, Nadine, Oscar, Rafael, and Sara further led to varying levels of damage in parts of the Americas.

CANADA

Costliest year on record for insurers

2024 was a historic year for insurance losses across Canada. Losses were driven by a very active summer season that drove annual insured losses beyond USD6.2 billion. This surpassed the previous record of USD5.3 billion (2016), which was driven by the devastating Fort McMurray wildfire. This fire remains the costliest individual loss event for the Canadian market.

The summer of 2024 brought a relentless series of thunderstorms, floods, and wildfires which prompted a record number of filed insurance claims in July and August, per data from the Insurance Bureau of Canada (IBC). There were no fewer than four individual billion-dollar-plus economic loss events: Mid-July flooding in southern Ontario (including Toronto), July/August's Jasper Wildfire Complex in Alberta, a costly Calgary (Alberta) hailstorm on August 5, and catastrophic flooding in southern Quebec (including Montreal) aided by the remnants of Hurricane Debby.

The August 5 Calgary hailstorm became the country's costliest insured SCS event on record (USD2.2 billion). This topped the previous record in June 2020 (USD1.2 billion in today's dollars) in which a hailstorm also struck Calgary. Alberta remains among the most at-risk places for SCS activity, especially hail. The set-up along the lee side of the Rockies is like the hail risk further south along the Rockies in the US state of Colorado. Cities such as Denver are also regularly affected by costly hail.

As the climate continues to warm, Canada is expected to endure an increasing number of extreme events such as heavier rainfall, more severe drought, and/or wildfires. This will further increase the cost of physical damage, but also put more vulnerable populations outside of Canada's main urban centers at risk. Proactive measures to ensure equitable protection against these risks are increasingly necessary.

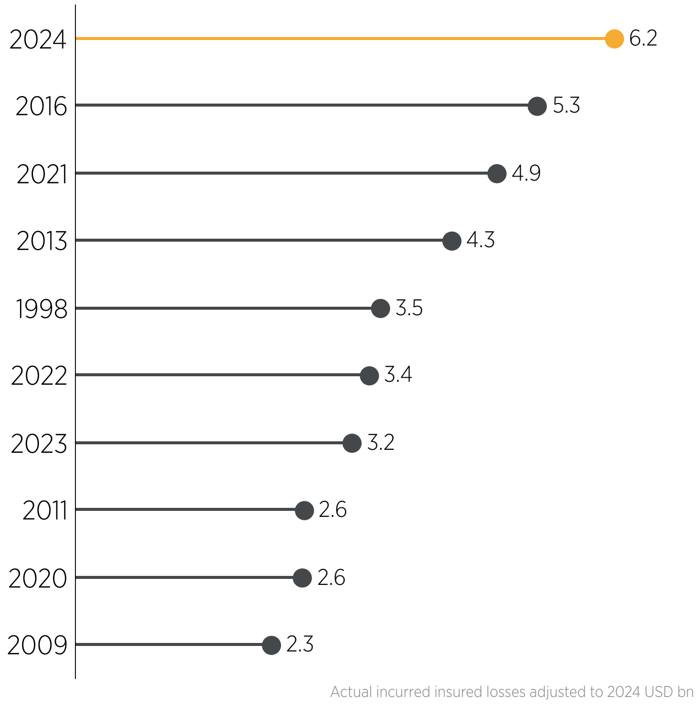


Figure 30: Canada's costliest insured loss years (2024 USD bn)
Graphic & Data: Gallagher Re

LATIN AMERICA / CARIBBEAN

Extensive wildfire and drought activity

Latin America faced numerous challenges emanating from extreme heat, volatility in precipitation, and fire ignitions. Chile endured among the worst impacts as the country recorded one of its deadliest wildfire outbreaks in decades. More than 137 people were killed in the Valparaiso region while as many as 15,000 properties were damaged or destroyed. Metro areas including Viña del Mar and Quilpué were heavily impacted. Economic losses from the fires were anticipated to exceed USD1 billion. The total area burned across Chile during the 2023/24 season reached nearly 74,000 hectares (183,000 acres). The Chile wildfire season spans from July to June.

Similar fire activity was recorded in Bolivia, where more than ten million hectares (24.7 million acres) were burned; a new modern record. Nearly 7 million hectares (17.3 million acres) were affected in the Santa Cruz region alone. Many homes and swaths of agricultural land were impacted. The record season was aided by continued human ignitions and worsened by hot and dry conditions enhanced by a warming climate.

Data from the ECMWF's Global Fire Assimilation System (GFAS) showed that the total wildfire carbon emissions across Bolivia in 2024 reached a modern record of nearly 120 megatons (Mt). Brazil's Amazon region likewise endured a record-breaking wildfire extent. In August, wildfires burning near São Paulo (Brazil) caused hundreds of millions (USD) in economic losses to agriculture and livestock alone. **Figure 31** highlights daily wildfire carbon emissions for Bolivia and Brazil dating to 2003. Paraguay and Venezuela likewise endured active fire seasons in 2024.

Extreme heat and a lack of rainfall, linked to lingering El Niño conditions, worsened the drought across Brazil and the larger Pantanal Region. Parts of Brazil experienced drought conditions from Acre and Amazonas and toward Minas Gerais. Several spots in Minas Gerais endured more than 100 days without measurable rainfall. 2024 drought-related economic losses in Brazil were estimated at USD6 billion. Lowered water levels in major rivers, including the Amazon, led to economically significant impacts to transportation and access to clean water.

Exceptional drought conditions worsened during the first half of 2024 in Mexico. According to the North American Drought Monitor, 76% of the country dealt with drought conditions by the end of May; the highest percentage since 2011. The drought resulted in a significant drop in corn production, and dire water supply issues in major cities, including the capital Mexico City.

Brazil: Rio Grande do Sul floods

Brazil's southern Rio Grande do Sul state was affected by catastrophic flooding in late April and early May. More than 180 were killed and millions were left without electricity or access to clean water (including the state capital of Porto Alegre). Significant damage at the Porto Alegre airport halted air traffic for nearly six months. The vast expanse of damage to property, infrastructure, and agriculture resulted in an economic loss estimated at USD14.5 billion. A lack of insurance take-up in the residential market meant that just USD1.5 billion of that total was covered by insurance; most of which was attributed to automobile or commercial-related claims.

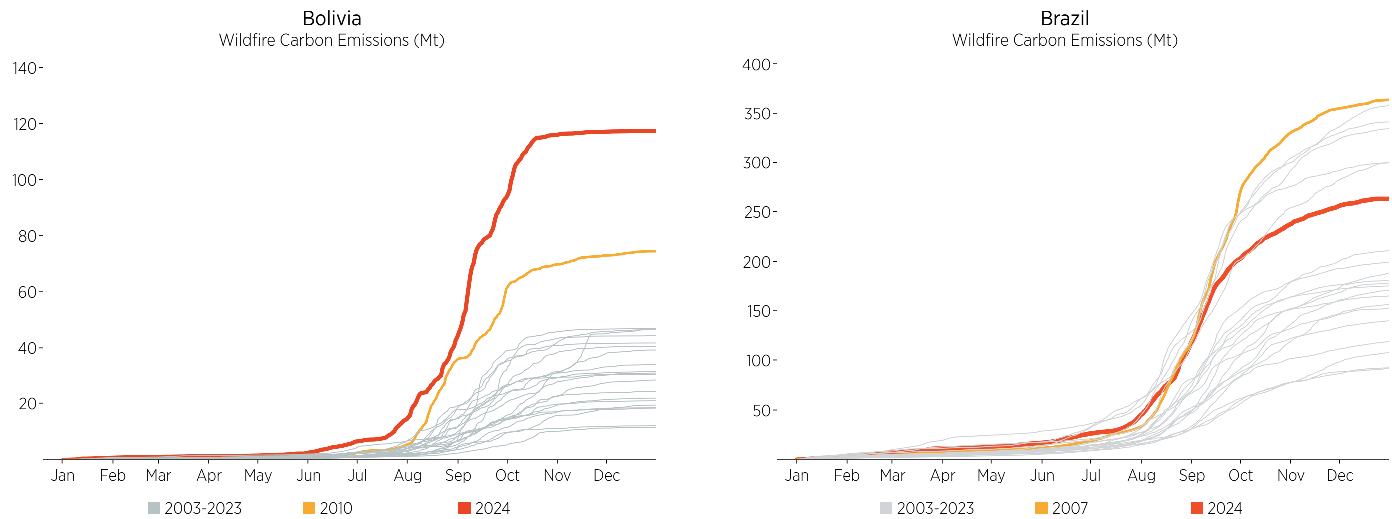


Figure 31: Total wildfire carbon emissions across Bolivia (left) and Brazil (right) in 2024 vs historical years (Mt C) | **Data:** ECMWF GFAS | **Graphic:** Gallagher Re

Europe / Middle East / Africa (EMEA)

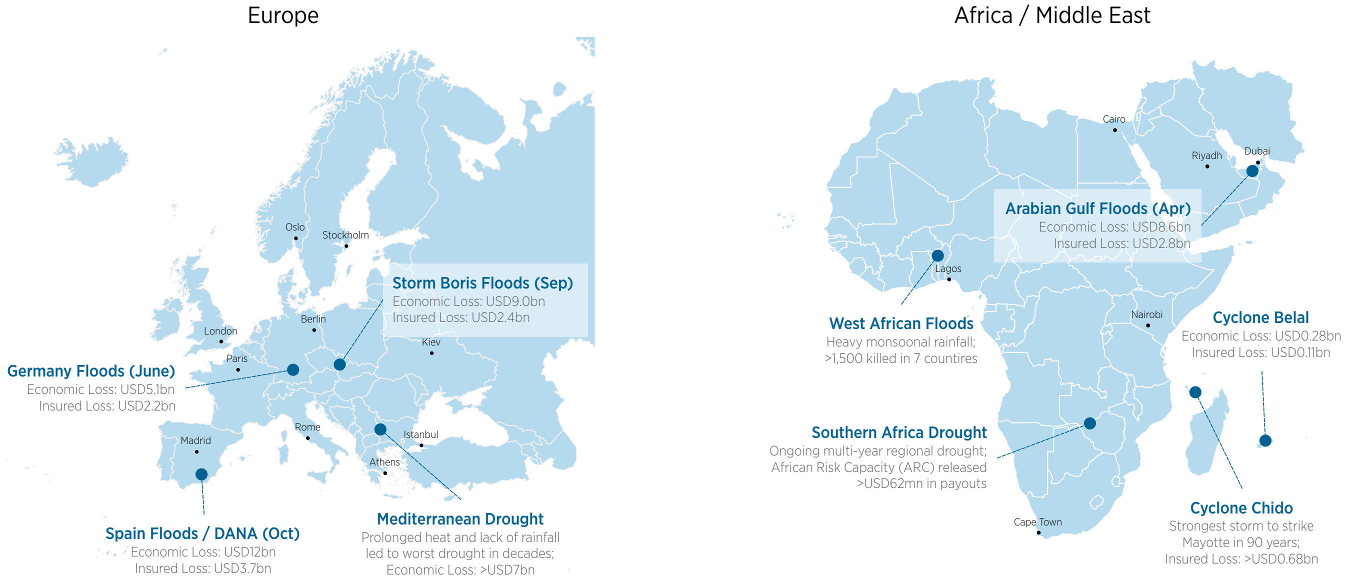
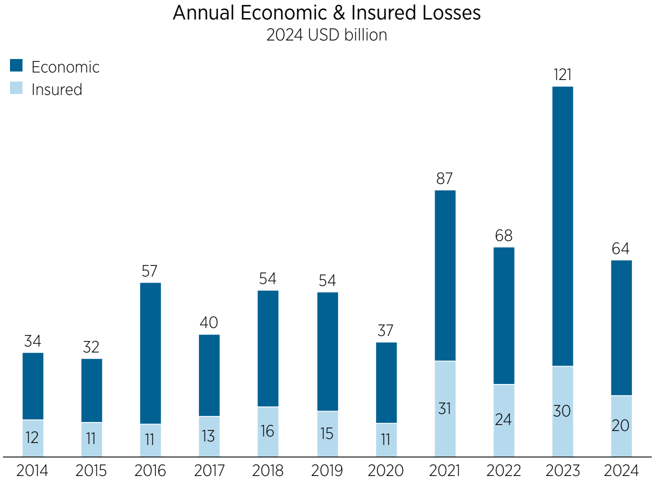
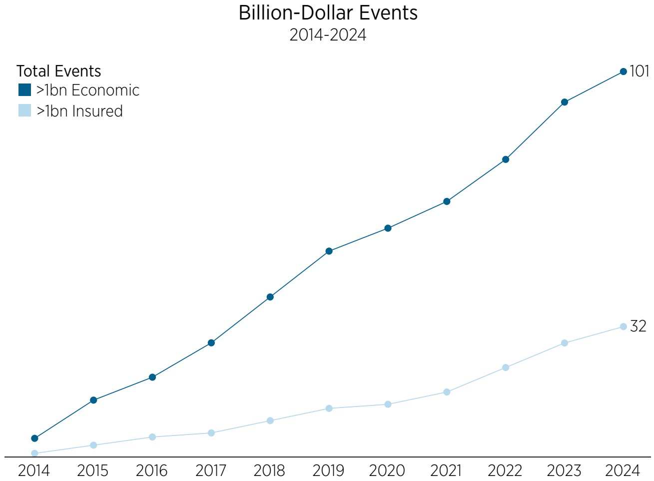


Figure 32: Map of notable Europe, Middle East, Africa (EMEA) events in 2024 | **Graphic & Data:** Gallagher Re





Notable Statistics: 2024

259.5
24-hour rainfall (mm) on April 16 setting a new official UAE record; 10.21 in

771.8
Rainfall (mm) in 14 hours on October 29 at Turís Mas de Calabarra (Spain); 30.39 in

68M
Number of people affected by drought conditions in Southern Africa

1.54°C
Record land temperature anomaly for warmest summer on record in Europe; 2.77°F above 1991-2020 average

Figure 33: Europe, Middle East, Africa (EMEA) natural catastrophe statistics in the past decade | **Graphic & Data:** Gallagher Re

EMEA: Takeaways

- High protection gap from 2024 events as economic losses topped USD64 billion, but insurance only covered USD20 billion
- At least four flood-related multi-billion dollar insured loss events recorded in Europe (three) and the Middle East (one)
- Europe: The financial cost from flood events alone reached USD29 billion; with insurance covering roughly USD10 billion
- Middle East: Arabian Gulf Coast flash flood event led to USD2.8 billion insured loss, costliest regional market event on record
- Drought impacts led to more than USD8 billion in economic losses across EMEA

The EMEA region endured above average economic and insured losses in 2024. Nearly every part of the continental region experienced anomalous weather and climate-driven catastrophes. High profile flooding events across Europe were driven by blocked or stalled weather patterns, where high- and low-pressure systems remained nearly stationary for several days. This resulted in prolific rainfall totals that prompted multi-billion-dollar insured loss costs in separate events affecting Southern Germany, Central Eastern Europe, and Spain. Unprecedented flash flooding also led to catastrophic damage and record-setting insured losses along parts of the Arabian Gulf Coast, including in the United Arab Emirates, Oman, and Bahrain.

Cyclone Chido left devastating impacts on the overseas French Island of Mayotte in December which resulted in economic losses into the single-digit billions (USD). The Category 4 storm left considerable loss of life and damage to island regions and parts of southern Africa. Elsewhere, humanitarian crises unfolded across Africa as southern regions endured one of the most extreme droughts in decades. An active rainy season in East Africa and anomalous rainfall in the Western Sahara resulted in widespread flooding that left thousands dead and significant physical damage to homes and agriculture.

EUROPE

EU flood: Protection gap and mitigation

Major flood-related events drove headlines across the European continent in 2024. (Re)insurers are focusing an increasing amount of attention on the flood peril in Europe, as market losses have become more prominent in recent years. The costliest European events of 2024 included the late May/early June flooding in southern Germany (Baden-Württemberg and Bavaria); large-scale floods in Central Eastern Europe associated with Storm Boris in mid-September; and an unprecedented volume of rainfall that inundated the Valencia Community of eastern Spain in late October.

While each flooding event is unique, these events were all enhanced by stalled or blocked weather patterns that featured a meandering low-pressure system which pulled energy and moisture from the anomalously warm waters of the Mediterranean Sea. A hallmark of climate change is an increased occurrence of blocked weather patterns, which in tandem with atmospheric and oceanic warming and more atmospheric moisture, is expected to bring further extreme precipitation events in the years to come.

Storm Boris

Exceptional rainfall totals associated with an area of low pressure named ‘Boris’ affected parts of Austria, Czechia (Czech Republic), and Poland in mid-September. Some communities recorded nearly 20 inches (508 millimeters) of rainfall. The remnants of Boris later produced heavy rainfall in Italy’s Emilia-Romagna region, which was previously devastated by flooding in May 2023. The total economic cost from Boris was estimated at more than USD9 billion. Just USD2.3 billion was covered by the private insurance market or public insurance entities.

While Boris ranks among the costliest flooding events in this part of the European continent, dramatic improvement in flood protection following previous major events in 1997, 2002, and 2013 helped to notably reduce damage impacts and loss costs. The return on investment in Central and Eastern Europe has been quite successful, which proves that mitigation strategies do work. However, significant damage to non-urbanized areas from Boris and other recent events indicates the need for more investment in regions outside large cities.

Valencia, Spain flooding

A cut-off area of low pressure, known locally as a 'Depresión Aislada en Niveles Altos (DANA)', prompted prolific record-setting rainfall across parts of eastern Spain in late October. This resulted in catastrophic damage in the Valencian Community. On October 29 (UTC) a rain gauge in Turís Mas de Calabarra measured 30.40 inches (771.8 millimeters) of rainfall. The maximum hourly rainfall during the period was 7.2 inches (184.6 millimeters), which marked a new countrywide record. At least 231 people were killed. The Consorcio de Compensación de Seguros (CCS), a government-run insurance consortium covering physical damage risk, reported insured losses beyond USD3.1 billion (EUR3.0 billion). Further losses were expected to be covered by AgroSeguro (agriculture) and private insurers. The overall economic loss was estimated at USD12 billion.

A main reason for the exceptional damage was due to a diversion of the Turia River away from Valencia's downtown, following the Great Flood of 1957. While this did lessen the overall damage impact in Valencia's city center during the 2024 event, this ended up diverting water further south. This part of Valencia has seen considerable population and exposure growth which ended up being directly affected by the enormous volume of water enhanced by the diversion project from decades earlier.

Southern Germany

Extensive flooding affected parts of southern Germany during late May and early June after a storm with origins over the Mediterranean Sea, known locally as a 'Vb cyclone', brought more than a months' worth of rainfall in a matter of days. Such low pressure systems, which intensify over the Mediterranean Sea and meander northwards toward Central and Western Europe, have historically been linked to a high risk of flooding. The southern Germany event was further enhanced by earlier spring season rainfall that left soils heavily saturated and vulnerable to run-off. The heaviest concentration of damage was recorded in Germany's Baden-Württemberg and Bavaria states. While not nearly as consequential as flood impacts from Storm Bernd in July 2021, the 2024 floods still left an economic toll of nearly USD5 billion. The total insured loss, which included impacts outside of Germany in parts of Italy, Switzerland, Hungary, Austria, and Czechia (Czech Republic), was estimated to be above USD2 billion.

Final thoughts

While the European floods of 2024 resulted in nearly USD10 billion in insured losses, there was still a sizable portion of damage which went uninsured. The total damage cost tallied USD29 billion, translating to more than 70% of losses not covered by insurance. The prominent protection gap, even in developed economies, continues to showcase how much work needs to be done to guarantee more insurance coverage. As costs from weather-related perils continue to grow, and the more obvious fingerprints of climate change are observed in the behavior of individual events, it is only becoming clearer that greater financial protection is needed.

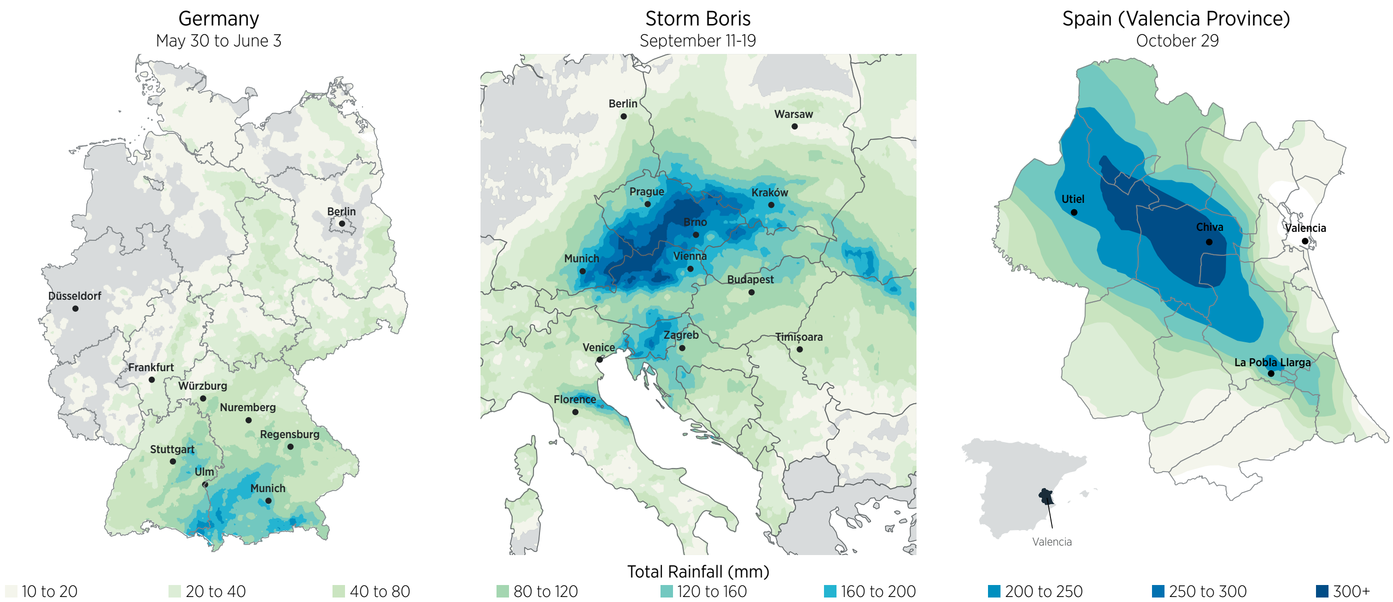


Figure 34: Precipitation (mm) for significant flooding events across Europe in 2024 | **Data:** DWD HYRAS / /NASA GPM / AEMET | **Graphic:** Gallagher Re

MIDDLE EAST AND AFRICA

Arabian Gulf flash floods

Record-setting rainfall resulted in historic flash flooding across parts of the Arabian Peninsula during April. The event was aided by warm surface waters in the Arabian Gulf and influenced by the strengthening of a positive phase of the Indian Ocean Dipole (IOD). The IOD is a fluctuation of sea surface temperatures (warm to cool) across the eastern and western Indian Ocean.

The heaviest rains fell on April 16 as the United Arab Emirates (UAE) reported its most significant rain totals in at least 75 years of recordkeeping. In the city of Al Ain, a record 10.21 inches (259.5 millimeters) of rain fell in less than a day. For context, the UAE averages between 6.0 to 7.8 inches (150 and 200 millimeters) during an average calendar year. This resulted in catastrophic flood damage throughout parts of the UAE, including in Dubai. Additional notable impacts occurred in Oman, Bahrain, and other surrounding countries.

Analysis conducted by Gallagher Re found that combined property and auto insured losses in the UAE alone were between USD2.15 billion and USD2.95 billion. The overall damage cost was even higher. The physical damage impacts were enhanced due to rapid urbanization that has led to major changes in land use. The intensity of the rainfall fell on arid soils over a short duration which put a huge strain on local infrastructure unequipped to handle such large volumes of water.

Africa: Drought and flood

A continuation of exceptional multi-year drought conditions persisted across parts of southern Africa. The drought, which initiated in 2023, notably worsened in 2024 and was enhanced by lingering El Niño conditions. Five countries (Lesotho, Malawi, Namibia, Zambia, and Zimbabwe) declared national drought disasters. Other nearby nations, such as Mozambique and Angola, also endured drought impacts. The lack of precipitation in tandem with extreme heat led to extensive damage to crops and heavy losses to livestock. The World Food Program (WFP) estimated at least 27 million people were struggling with food insecurity. The economic cost of the drought led to more than USD1 billion in losses. Sub-Saharan Africa is among the most vulnerable localities to climate change due to a dependence on rain-fed agriculture. Many nations are also part of the developing economic world and do not yet have the financial resources available to fund mitigation projects or withstand significant economic shocks.

While much of southern Africa was facing drought, other parts of the continent experienced extreme seasonal flooding. Parts of East Africa were particularly impacted as tens of thousands of homes and vast areas of cropland were inundated between March and May. At least 565 people were killed. The floods were augmented by a positive phase of the Indian Ocean Dipole and further exacerbated by tropical moisture from the passage of cyclones Hidaya and Ialy. In the hardest hit countries of Tanzania and Kenya, combined economic flood and tropical cyclone related losses exceeded USD850 million.

There was even more anomalous rainfall in western and central Africa in Q3, as a northwest shift of the seasonal African monsoon led to catastrophic impacts. More than 1,000 people were killed in parts of Chad, Nigeria, Mali, and Niger alone. Many areas typically considered desert saw vast vegetative growth. Millions of people were affected. Note that this northern shift in the monsoonal trough played a critical role in the unexpected lull in the Atlantic hurricane season from mid-August through mid-September.

Cyclone Chido

Cyclone Chido brought catastrophic impacts to several island regions as a Category 4 equivalent storm in mid-December, including the islands of Agaléga (Mauritius) and Mayotte (France). The storm would later come ashore on the African mainland in northern Mozambique. Chido was the strongest to strike the overseas French island of Mayotte in at least 90 years and caused tremendous damage. Hundreds of people were killed along Chido's path. The storm resulted in economic losses reaching the single-digit billions (USD). It also led to an insured loss impact in Mayotte exceeding USD675 million, marking one of the costliest natural disasters in this part of the world on record.

African Risk Capacity (ARC)

Gallagher Re is the lead broker and risk advisory for the African Risk Capacity Group (ARC Ltd) and helps place innovative parametric products. In October 2024, the two groups worked with the UN World Food Programme (WFP) to structure the Sahel Climate Catastrophe Layer (SCCL), a parametric product designed to trigger payouts during severe regional droughts. The product helps connect private sector capital with national WFP offices and is expected to protect 750,000 people in vulnerable communities facing food insecurity. Separately, the ARC distributed more than USD62 million in disaster risk insurance payments in 2024, primarily due to drought.

Asia-Pacific (APAC)

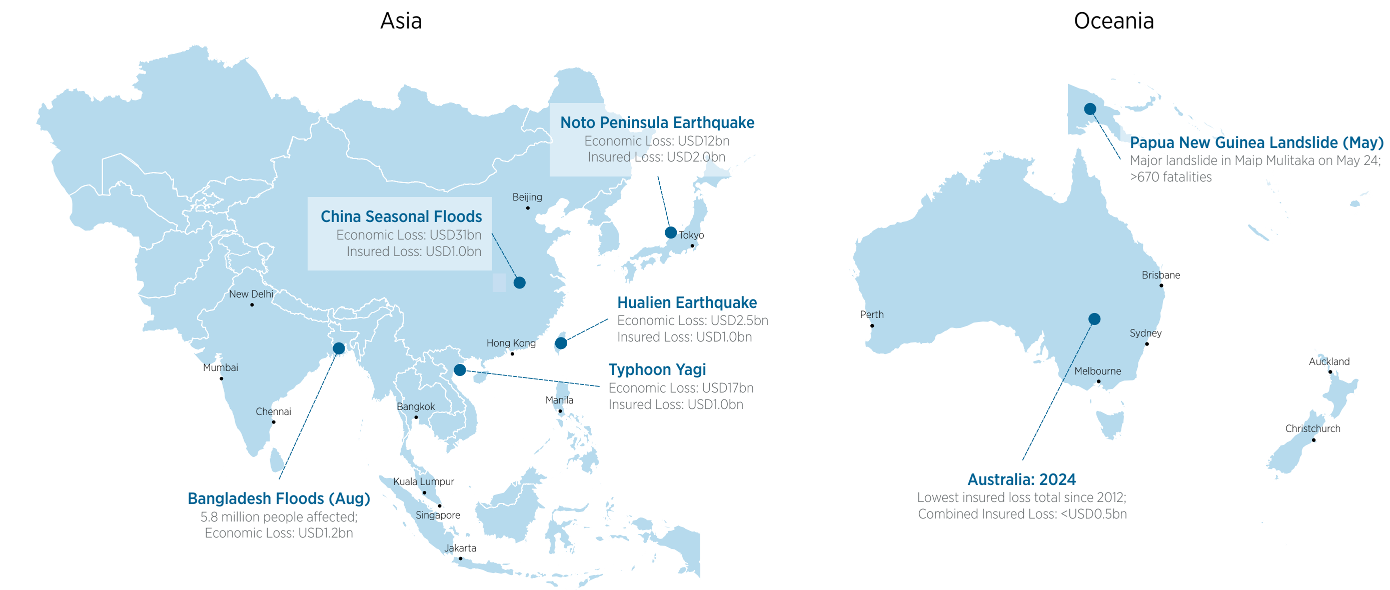
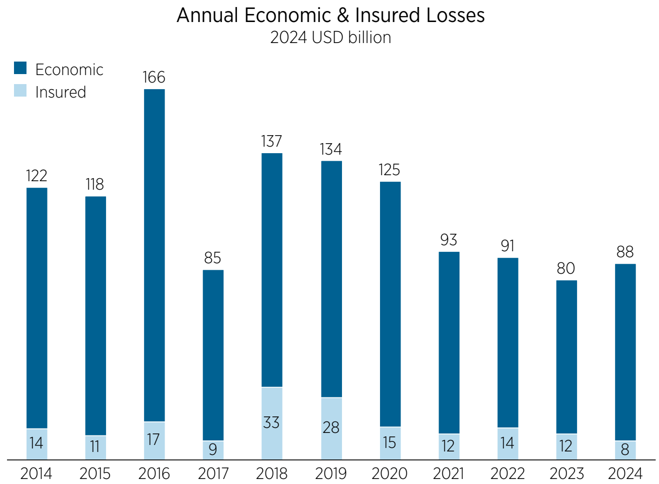
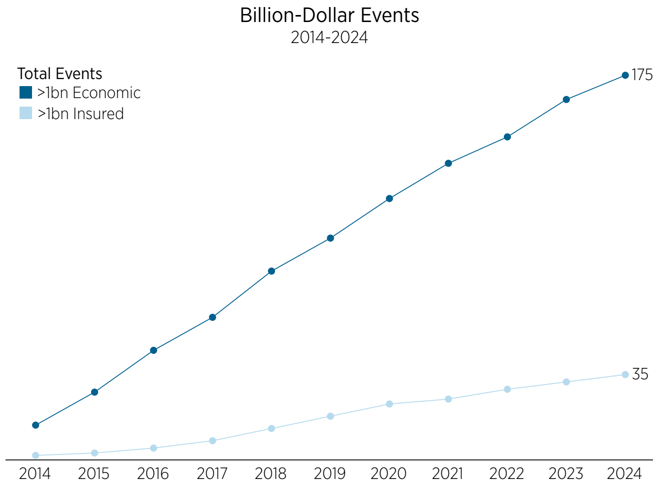


Figure 35: Map of notable Asia-Pacific (APAC) events in 2024 | **Data & Graphic:** Gallagher Re





Notable Statistics: 2024

M7.4	10	28.6	679
Strongest earthquake recorded in Taiwan since 1999 (April 3)	Span of days in November which 4 typhoons made landfall in the Philippines	Snow depth (cm) in Seoul, South Korea on November 28 (11.3 in); third-highest snowfall ever recorded in the city	Record 24-hour rainfall (mm) in Hunan Province (China) on July 28; Remnants of Typhoon Gaemi (26.73 in)

Figure 36: Asia-Pacific (APAC) natural catastrophe statistics in the past decade | **Data & Graphic:** Gallagher Re

APAC: Takeaways

- 2024: Fourth consecutive year that total economic loss costs from natural catastrophes in APAC did not exceed USD100 billion
- Insured losses (USD8 billion) were the lowest in APAC since 2012 (USD7 billion in today's dollars)
- Three events (China seasonal floods, Typhoon Yagi, and Japan's Noto Peninsula Earthquake) drove 68% of economic losses
- M7.4 earthquake in Hualien became Taiwan's strongest recorded tremor since 1999
- Oceania (notably Australia and New Zealand) insurance market records first sub-billion (USD) natural peril loss year since 2012

The APAC region endured one of its most benign years for natural catastrophe-related losses in more than a decade. The USD88 billion in economic losses was slightly above the 2023 total (USD80 billion) but became the fourth consecutive year where damage costs from natural perils did not top USD100 billion. Between 2008 and 2020, only three years fell below this threshold (2009, 2012, 2017). Lingering early calendar year influence from El Niño and then ENSO-neutral conditions helped limit any above-average tropical cyclone activity, or any enhancement of seasonal monsoonal patterns. The insurance market impact in APAC was similarly manageable, with insured losses slightly above USD8 billion. This marked the lowest total since 2012.

While aggregated loss activity was below normal, APAC was impacted by several large and consequential events. The three individual billion-dollar (USD) insured loss events included the Noto Peninsula earthquake in Japan (USD2 billion), Typhoon Yagi (USD1 billion), and the Hualien earthquake in Taiwan (USD1 billion). A severe April hailstorm in Japan's Hyogo Prefecture (USD935 million) and aggregated payouts from China's seasonal summer monsoon flooding (USD930 million) were the only other APAC events with insured losses approaching the billion-dollar threshold.

ASIA

Taiwan earthquake

The island of Taiwan was struck by a USGS-registered magnitude-7.4 earthquake on April 3 near Hualien. This was the strongest earthquake in Taiwan since the Chi-Chi earthquake in 1999. The April tremor resulted in hundreds of properties being severely or moderately damaged. Field surveys showed that ground floor buildings with high ceilings and/or high-rise buildings with weak supporting structures (e.g. triangular-windowed buildings) suffered the most damage. The Taiwan Residential Earthquake Insurance Fund (TREIF) paid out at least USD15 million (NTD473 million) to indemnified households, its largest payout since 2002.

The bulk of the USD1 billion insurance claims came from the commercial sector, particularly from semiconductor facilities. Taiwan is the second-largest semiconductor producer in the world and primarily through the Taiwan Semiconductor Manufacturing Co Ltd (TSMC). TSMC reported that most damage to its facilities was due to wafer scrapping and material damage. Wafer already in a furnace during an electrical interruption has a high rate of being scrapped. Other tech companies which were affected included Nanya Technology and AUO Corporation. Taiwan has enacted stringent building codes to absorb strong ground shaking. That helped limit damage from the April 2024 event.

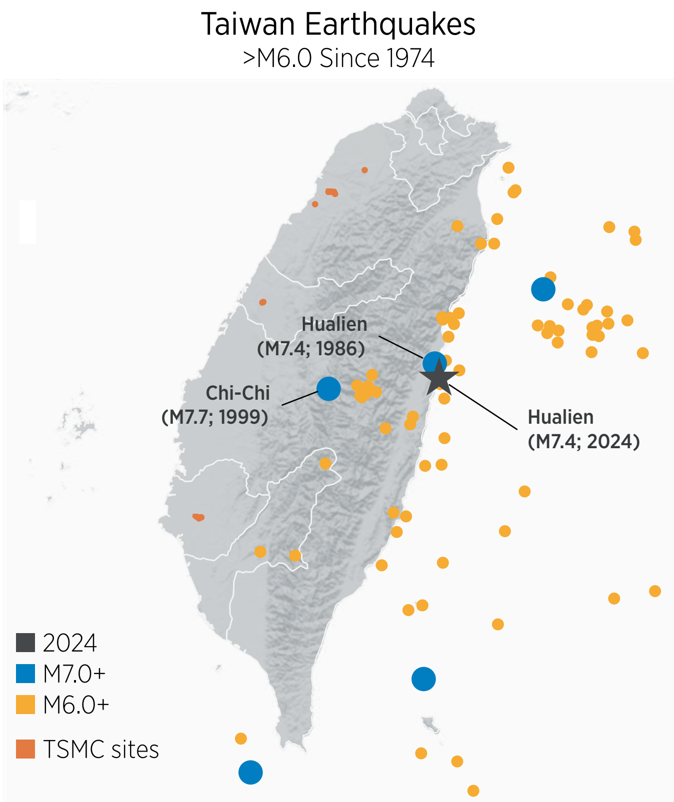


Figure 37: Recent large earthquakes in / near Taiwan | **Earthquake Data:** USGS
Graphic: Gallagher Re

Typhoon Yagi

Typhoon Yagi's track through the South China Sea left devastating impacts across several countries in Southeast Asia. The worst damage was recorded in parts of northern Vietnam and southern China's Hainan Province. The storm officially left at least 842 people dead. The total economic damage was estimated at nearly USD17 billion. Just USD1 billion was covered by insurance, and primarily in China and Vietnam.

Yagi came ashore in Vietnam as a Category 4 equivalent storm, which marked the strongest tropical cyclone to strike the country on record. It also became the longest-lasting tropical cyclone to affect the country. Excessive moisture initiated extreme rainfall totals and subsequent flooding in northern Vietnam. The storm caused up to USD3.3 billion in economic damage in that country alone. Roughly 45% of the damage was tied to the agricultural sector. Heavy losses also occurred to industries particularly in the Hai Phong area, followed by commercial entities along the Red Riverbank in Hanoi.

Most of the damage in China was incurred on Hainan. Government officials noted losses there alone exceeded USD12 billion. Hundreds of millions (USD) of the cost were covered by insurance. The storm's high winds put wind farms and photovoltaics to the test. China's current five-year plan calls for growth across its renewable energy sector, with wind and solar energy now generating at least 37% of the country's power. Yagi's high winds led to damage to wind farms and solar panel cells linked to Huaneng Group, Hainan Holdings Energy, and Jinko Power Technology. More than 68,000 homes were also damaged in Haikou, Wenchang, Chengmai, and Lingao.

The combined insured loss in these two countries alone neared USD1 billion, and nearly 500 people lost their lives. The remnants of Yagi later resulted in a humanitarian crisis and sizable economic losses in parts of Lao PDR, Thailand and Myanmar. The event also triggered a SEADRIF Insurance payout in Lao PDR.

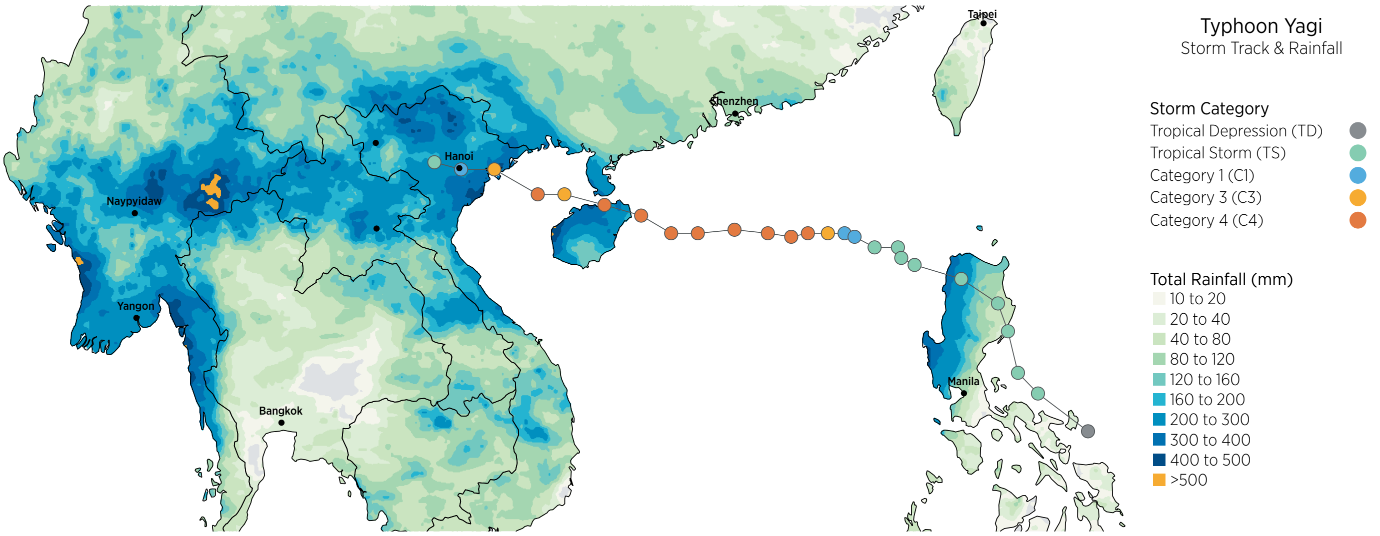


Figure 38: Storm track of Typhoon Yagi and estimated rainfall totals | **Rainfall Data:** NASA | **Storm Track Data:** NOAA / JTWC | **Graphic:** Gallagher Re

Oceania

AUSTRALIA, NEW ZEALAND, AND PAPUA NEW GUINEA

2024 was one of the quietest years for losses across Oceania. The Insurance Council of Australia did not declare an insurance catastrophe for any event in 2024, and only declared two 'Significant Events'. The first was a series of thunderstorms on February 14 in parts of Victoria and a second for thunderstorms and subsequent flooding in parts of New South Wales and Queensland in April. Neither event topped the USD250 million threshold. New Zealand equally saw limited natural catastrophe activity.

For perhaps the first time since 1989, the New Zealand Insurance Council did not list a single individual event as having caused enough damage or filed claims to warrant being listed. Elsewhere in Oceania, the most notable event was a major landslide in Papua New Guinea on May 24. At least 670 people were officially listed as dead after recent weeks of heavy rainfall and a minor earthquake in the days prior reportedly destabilized the mountainous terrain.

Appendix

2024 Events: Event Statistics

Please note that the Appendix solely includes a listing of global events that resulted in approximately 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 and further implementation of CPI variables such as 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	Fatalities
South Africa Drought	Jan 1 – Dec 31	Africa	ZA	150	-
Malawi Drought	Jan 1 – Dec 31	Africa	MW	400	-
Zambia Drought	Jan 1 – Dec 31	Africa	ZM	230	-
Zimbabwe Drought	Jan 1 – Dec 31	Africa	ZW	500	-
China Drought	Jan 1 – Dec 31	Asia	CN	970	-
India Drought	Jan 1 – Dec 31	Asia	IN	300	-
Philippines Drought	Jan 1 – Apr 30	Asia	PH	175	-
Austria Drought	Jan 1 – Dec 31	Europe	AT	600	-
Spain Drought	Jan 1 – Dec 31	Europe	ES	3,170	-
Serbia Drought	Jan 1 – Dec 31	Europe	RS	1,100	-
Türkiye Drought	Jan 1 – Dec 31	Europe	TR	500	-
Romania Drought	Jan 1 – Dec 31	Europe	RO	1,800	-
Brazil Drought	Jan 1 – Dec 31	Latin America	BR	6,000	-
Ecuador Drought	Jan 1 – Dec 31	Latin America	EC	100s of millions	-
Mexico Drought	Jan 1 – Dec 31	Latin America	MX	2,000	-
Australia Drought	Jan 1 – Dec 31	Oceania	AU	625	-
US Drought	Jan 1 – Dec 31	US	US	7,000	-

Earthquake

Event Name	Date	Region	Countries	Economic Loss	Fatalities
Noto Peninsula Earthquake	Jan 1	Asia	JP	12,000	505
Uqturpan Earthquake	Jan 23	Asia	CN, KZ	425	3
Hualien Earthquake	Apr 3	Asia	TW	2,500	18
Vanuatu Earthquake	Dec 17	Oceania	VU	100	16

European Windstorm

Event Name	Date	Region	Countries	Economic Loss	Fatalities
Isha / Iris	Jan 20–22	Europe	BE, CH, DE, DK, FR, GB, IE, NL, NO	525	5
Jocelyn / Jitka	Jan 23–24	Europe	GB, IE, DE, DK, NL, NO, PL	160	-
Ingunn / Margrit	Jan 31–Feb 1	Europe	NO, GB, IE, SW	150	-
Louis / Wencke	Feb 21–23	Europe	FR, BE, NL, DE, DK, SE	600	1
Nelson / Nadja	Mar 27–29	Europe	FR, PT, ES, GB	100	4
Olivia / Sabine & Kathleen / Timea	Apr 4–7	Europe	IE, GB, FR, ES, PT, NL	125	-
Bert / Sigrid	Nov 22-24	Europe	GB, IE	600	5
Darragh	Dec 5-12	Europe	GB, IE, FR	175	3

Flooding/Landslides

Event Name	Date	Region	Countries	Economic Loss	Fatalities
Jan Congo Floods	Jan 1–17	Africa	CD	10s of millions	238
South Africa Jan Flood	Jan 10–20	Africa	ZA	10s of millions	13
Simiyu Region Landslide	Jan 13	Africa	TZ	-	22
East Africa Rainy Season	Mar 24–May 15	Africa	TZ, KE, UG, RW, ET, PG	670	567+
Idiofa Town Landslide	Apr 13	Africa	CD	-	15
Algeria Spring Floods	May 24–Jun 8	Africa	DZ	-	15
Chad Seasonal Floods	Jun 1-Sep 30	Africa	TD	380	487
Niger Summer Floods	Jun 10-Sep 30	Africa	NE	225	265
Ivory Coast Floods	Jun 17-25	Africa	CI	-	27
Burkina Faso Floods	Jul 1-Sep 30	Africa	BF	275	-
Cameroon Floods	Jul 1-Sep 30	Africa	CM	115	-
C. African Republic Floods	Jul 1-Sep 30	Africa	CF	145	-
DRC Annual Floods	Jul 1 -Sep 30	Africa	CD	875	-
S. Ethiopia Landslides	July 20-23	Africa	ET	-	257
Nigeria Floods	Aug 6-Sep 30	Africa	NG	225	269
Mali Floods	Jul 22-Sep 30	Africa	ML	165	62
Arbaat Dam Collapse	Aug 25	Africa	SD	20	60
Morocco Floods	Sep 6-8	Africa	MA	-	11
Uganda Landslide	Nov 26-28	Africa	UG	-	28
Caraga & Davao Flood	Jan 16–19	Asia	PH	30	18
Zhenxiong Landslide	Jan 22	Asia	CN		44
Mindanao Flood/Landslide	Jan 28–Feb 6	Asia	PH	50	120
Nuristan Landslide	Feb 18	Asia	AF	-	25
Afghanistan & Pakistan Flood	Feb 20-May 18	Asia	AF, PK	30	741
West Sumatra Floods	Mar 7–8	Asia	ID	65	32
Central Java Floods	Mar 13–14	Asia	ID	-	13
Snowmelt & Orsk Dam Burst	Mar 27–Apr 20	Asia	RU, KZ	570	3

Tana Toraja Landslide	Apr 13	Asia	ID	-	20
China April Flood	Apr 15–21	Asia	CN	1,650	24
China May Flood	May 1–31	Asia	CN	165	3
South Sulawesi Flood	May 3	Asia	ID	-	16
West Sumatra Lahar	May 11	Asia	ID	30+	67
Sri Lanka Seasonal Floods	May 15–Jun 30	Asia	LK	Millions	37
China Seasonal Floods	Jun 1–Sep 30	Asia	CN	31,000	605
India Seasonal Floods	Jun 4–Sep 30	Asia	IN	2,050	1,878
Nepal Seasonal Floods	Jun 11–Sep 30	Asia	NP	350	468
Pakistan Seasonal Floods	Jul 1-Sep 30	Asia	PK	Millions	341
South Korea Floods	Jul 6-18	Asia	KR	250	5
Bone Bolango Landslide	Jul 6-7	Asia	ID	-	23
Ha Giang Landslide	Jul 13	Asia	VN	-	11
Eastern Afghanistan Floods	Jul 15-16	Asia	AF	-	58
Akita and Yamagata Floods	Jul 25	Asia	JP	720	5
Thailand Floods	Aug 16-30	Asia	TH	210	22
Bangladesh Floods	Aug 20-Sep 3	Asia	BD	1,200	71
North Maluku Floods	Aug 25	Asia	ID	-	19
Noto Peninsula Heavy Rain	Sep 21-23	Asia	JP	10s of millions	16
North Sumatra Floods	Nov 23	Asia	ID	-	31
Malaysia and Thailand Flood	Nov 27-29	Asia	MY, TH	500	37+
Henk / Annelie & Flooding	Jan 1–5	Europe	BE, DE, FR, NL, GB	610	3
Italy / Germany Floods & SCS	May 14-17	Europe	DE, IT	600	-
Southern Germany & Central Europe Floods	May 28-Jun 5	Europe	DE, IT, CH, HU, AT	5,050	10
Southern Spain Floods	Jun 10-15	Europe	ES	150	-
Xandria / Alps Floods	Jun 21-23	Europe	CH, FR, IT, CZ, BA, PO, HU	220	5
Storm Annelle	Jun 28-30	Europe	FR, IT, CH, AT	525	7
Boris / Anett	Sep 11-18	Europe	AT, CZ, RO, HU, DE, SK, PL, SI, IT	9,200	26
Bosnia / Herzegovina Floods	Oct 4	Europe	BA	40	22
Southern France / Italy Floods	Oct 16-20	Europe	FR, IT	900	1
Eastern Spain DANA	Oct 28-30	Europe	ES	12,000	231
Bolivia Q1 Floods	Jan 1-Mar 31	Latin America	BO	10s of millions	50
Colombia Landslide	Jan 12	Latin America	CO	Millions	36
Rio De Janeiro Jan Floods	Jan 13-14	Latin America	BR	90	12
Southeast Brazil Floods	Mar 22-23	Latin America	BR	90	27
April Para Floods	Apr 1-2	Latin America	BR	300	-
Rio Grande do Sul Floods	Apr 27-May 13	Latin America	BR	14,500	180
Central America Flooding	Jun 15-Jun 24	Latin America	MX, SV, GT, HN, EC	180	30
Panama Floods	Oct 31-Nov 4	Latin America	PA	100	11

Arabian Gulf Flash Flood	Apr 13-17	Middle East	AE, OM, YE, BH, QA, IR, SA	8,550	33
Yemen August Floods	Aug 2-7	Middle East	YE	Millions	45
Jiroft Floods	Sep 30-Oct 1	Middle East	IR	-	15
Chimbu Floods	Mar 13-19	Oceania	PG	50	23
Maip Mulitaka Landslide	May 24	Oceania	PG	-	670
Toronto Floods	Jul 15-16	N. America	CA	2,250	-
Southern Ontario Floods	Aug 17-18	N. America	CA	275	-
British Columbia AR	Oct 18-20	N. America	CA	200	3
Western Haiti Floods	Dec 20-30	N. America	HT	-	13
S. California Flash Flood	Jan 19-22	US	US	500	-
Western Atmospheric River	Jan 31-Feb 1	US	US	100	-
CA Atmospheric River #1	Feb 3-6	US	US	1,200	9
CA Atmospheric River #2	Feb 17-21	US	US	150	-
Southern Florida June Floods	Jun 10-14	US	US	750	-
Midwest Summer Flooding	Jun 19-30	US	US	1,000	2
US Gulf Coat Flooding	Sep 1-7	US	US	500	-
PTC8 / Carolinas Floding	Sep 16-17	US	US	200	-
New Mexico Flash Floods	Oct 17-20	US	US	250	2

Severe Convective Storm

Event Name	Date	Region	Countries	Economic Loss	Fatalities
South Africa Cut-Off Low	May 31–Jun 4	Africa	ZA	50	23
Uganda Lightning & SCS	Nov 2	Africa	UG	-	14
Malawi December Storms	Dec 6	Africa	MW	-	11
China April SCS	Apr 1–31	Asia	CN	310	17
Hyogo Hailstorm	Apr 16	Asia	JP	1,300	-
China May SCS	May 1–31	Asia	CN	140	13
Mumbai and Delhi Dust Storm	May 10–13	Asia	IN	-	19
West Bengal Malda Storm	May 16	Asia	IN	-	12
North China July SCS	Jul 1-31	Asia	CN	220	10
China August SCS	Aug 11-27	Asia	CN	380	17
West Tokyo Hail	Sep 19	Asia	JP	200	-
Easter Weekend SCS	Mar 30–Apr 3	Europe	CZ, FR, IT, PO	100	5
Storm Tina	Jun 6–10	Europe	AT, DE, HU, CH, SK, RO	515	2
Storm Wibke	Jun 17–20	Europe	DE, FR, CZ, PO, CH, BE	550	-
Storm Zoe	Jun 26-28	Europe	DE, CZ, PL, SK	325	-
Storm Elke	Jul 9-12	Europe	FR, DE, BE, PL, CZ, AT, KS	270	4
Storm Frieda	Jul 12-14	Europe	IT, DE, AT, PL, SI, BY	925	3
Early August SCS	Aug 6-8	Europe	AT, DE, CH, IT	180	1
Mid-August SCS	Aug 12-13	Europe	CH, DE	600	-

Central & Northern Italy Hail	Aug 26-27	Europe	IT	100	-
Para March SCS	Mar 5	Latin America	BR	200	
Argentina Hail & Floods	Mar 8–21	Latin America	AR	250	1
Southern Brazil Late-May SCS	May 27-30	Latin America	BR	105	-
Chile June SCS	Jun 10–16	Latin America	CL	100	1
Ecuador June SCS	Jun 15–16	Latin America	EC	10s of millions	19
Late-June SCS	Jun 21-24	Latin America	BR	100	-
UAE Hail & Floods	Feb 11–13	Middle East	AE, OM	250	4
Victoria Valentine's Day SCS	Feb 14	Oceania	AU	200	-
Severe Weather NSW & QLD	Apr 3-8	Oceania	AU	280	1
Saskatchewan SCS	Jun 23	N. America	CA	130	-
Calgary Hailstorm	Aug 5	N. America	CA	2,800	-
Early Jan SCS & WW	Jan 8–10	US	US	2,800	6
Jan Southern SCS & Flood	Jan 22–26	US	US	650	
Early Feb Outbreak	Feb 8–13	US	US	1,225	1
Feb Polar Front & SCS	Feb 26–28	US	US	1,620	
Western US Storm	Feb 28–Mar 4	US	US	130	2
Early March Storm Complex	Mar 6–11	US	US	655	
Mid-March SCS Outbreak	Mar 12–17	US	US	6,200	3
San Antonio Hail & SCS	Mar 21–23	US	US	750	
Late March Southern SCS	Mar 24–28	US	US	200	
Early-April Outbreak	Mar 31–Apr 4	US	US	2,625	1
Southern SCS & Floods	Apr 6–12	US	US	2,700	-
April Mid-Atlantic SCS	Apr 14–16	US	US	115	-
April Plains & Midwest SCS	Apr 15–16	US	US	100	-
Central & Eastern Outbreak	Apr 17–20	US	US	975	-
Texas April SCS	Apr 19–21	US	US	300	-
Late April Central SCS	Apr 25–29	US	US	1,725	6
Early May Hail & Flooding	Apr 30–May 2	US	US	525	1
Texas Flooding & SCS	May 3–5	US	US	350	-
Early-May SCS	May 6–10	US	US	6,900	5
Southern Flood & SCS	May 11–14	US	US	1,300	-
Houston Derecho	May 15–19	US	US	2,000	8
Mid-May SCS	May 17–22	US	US	5,250	5
Late May Plains Outbreak	May 23–24	US	US	725	-
Late May Central & East SCS	May 25–26	US	US	4,900	21
Dallas Hail & SCS	May 27–29	US	US	3,500	2
Denver Hail & SCS	May 30–Jun 1	US	US	3,425	-
TX Hail & MD Tornadoes	Jun 2–5	US	US	650	3
Early June Outbreak	Jun 6–10	US	US	750	-
Colorado June SCS	Jun 9-10	US	US	155	-

Midwest Mid-June Outbreak	Jun 12–14	US	US	1,025	-
Central & East Mid-June SCS	Jun 14–18	US	US	260	-
Central & East Late-June SCS	Jun 19–25	US	US	910	-
Midwest Late-June Outbreak	Jun 24–26	US	US	1,975	2
US Late-June Outbreak	Jun 27-30	US	US	595	-
Early July Plains Outbreak	Jul 1-4	US	US	160	-
Early July Central Outbreak	Jul 6-7	US	US	145	-
Chicago Derecho & SCS	Jul 13-18	US	US	2,980	5
Arizona Monsoon SCS	Jul 14-15	US	US	200	-
Late July Central Outbreak	Jul 19-20	US	US	245	-
Southeast SCS & Flooding	Jul 19-24	US	US	275	-
July Southwest Monsoon	Jul 21-15	US	US	150	-
Late July US SCS Outbreak	Jul 24-Aug 1	US	US	1,125	-
Early Aug Eastern Outbreak	Aug 2-3	US	US	280	-
Minnesota Aug SCS	Aug 3-5	US	US	150	-
Northeast July SCS	Aug 4-6	US	US	770	-
Mid-August SCS & Floods	Aug 12-19	US	US	1,230	2
August Northern Outbreak	Aug 22-30	US	US	1,200	-
Oklahoma City Hail & SCS	Sep 21-24	US	US	925	-
Oklahoma Tornado Outbreak	Nov 2-5	US	US	575	5
Mid-Dec Atmospheric River	Dec 13-16	US	US	160	-
Southern US Outbreak	Dec 28-29	US	US	1,200	4

Tropical Cyclone

Event Name	Date	Region	Countries	Economic Loss	Fatalities
Cyclone Belal	Jan 14-16	Africa	RE, MU	275	4
Cyclone Gamane	Mar 27-29	Africa	MG	75	19
Cyclone Hidaya	May 3-5	Africa	TZ	185	5
Cyclone Chido	Dec 11-15	Africa	YT, MZ, MW, MU	3,900	Hundreds
Cyclone Remal	May 26-28	Asia	IN. BD	670	84
Tropical Storm Prapiroon	Jul 21-23	Asia	LA, VN	35	18
Typhoon Gaemi	Jul 23-28	Asia	TW, CN, PH	2,575	151
Cyclone Asna	Aug 25-Sep 3	Asia	IN, PK	100	73
Typhoon Shanshan	Aug 28-31	Asia	JP	900	8
Depression 03	Sep 1-2	Asia	IN	1,050	27
Typhoon Yagi	Sep 1-12	Asia	CH, PH, VN, LA, TH, MM	16,830	842
Depression 05	Sep 13-18	Asia	IN, BD	50	50
Typhoon Bebinca	Sep 15-17	Asia	CN, PH	950	8
Tropical Storm Soulik	Sep 16-21	Asia	PH, VN	20	17
Typhoon Krathon	Sep 28-Oct 3	Asia	PH, TW	125	18
Tropical Storm Trami	Oct 23-30	Asia	PH, CN, VN	450	162
Typhoon Kong-rey	Oct 28-Nov 4	Asia	PH, TW, CN, KR, JP	225	15
Typhoon Man-yi	Nov 16-18	Asia	PH	65	14
Cyclone Fengal	Nov 26-Dec 1	Asia	IN, LK	55	26
Hurricane Ernesto	Aug 13-19	Latin America	BM, PR, VI, AG, GP	150	-
Hurricane John	Sep 22-28	Latin America	MX	2,450	29
Tropical Storm Sara	Nov 14-18	Latin America	HN, BZ	100	4
Tropical Cyclone Kirrily	Jan 25-27	Oceania	AU	120	-
Tropical Storm Alberto	Jun 19-21	US	US, MX	165	4
Hurricane Beryl	Jul 1-12	US	US, GD, VC, TT, MQ, BB, KY, JM, MX, VE	8,250	28
Hurricane Debby	Aug 4-10	US	US, CA	7,000	8
Hurricane Francine	Sep 10-15	US	US	1,200	-
Hurricane Helene	Sep 24-28	US	US, CU, MX	78,000	219
Hurricane Milton	Oct 7-10	US	US, MX	35,000	33

Wildfire

Event Name	Date	Region	Countries	Economic Loss	Fatalities
N Portugal Wildfires	Sep 14-18	Europe	PT	520	7
Central Chile Wildfires	Feb 1–Mar 22	Latin America	CL	1,000	137
Peru Seasonal Wildfires	Jul 1-Sep 30	Latin America	PE	Millions	16
Bolivia Wildfires	Jul 1-Nov 1	Latin America	BO	100	-
Brazil / Sao Paulo Brazil Fires	Aug 23-Sep 6	Latin America	BR	375	2
Jasper Fire Complex	Jul 22-Aug 17	N. America	CA	1,300	1
Smokehouse Creek Fire	Feb 26–Mar 15	US	US	420	2
South Fork & Salt Fires	Jun 17–25	US	US	1,750	2
Borel Fire	Jul 24-Aug 20	US	US	250	-
Park Fire	Jul 24-Aug 20	US	US	550	-
Mountain Fire	Nov 11-13	US	US	725	-

Winter Weather

Event Name	Date	Region	Countries	Economic Loss	Fatalities
China January Freeze	Jan 12–23	Asia	CN	365	3
China Feb Winter Freeze #1	Feb 1–5	Asia	CN	1,770	7
China Feb Winter Freeze #2	Feb 17–22	Asia	CN	980	-
Seoul Nov Winter Weather	Nov 26-28	Asia	KR	120	5
Europe April Freeze	Apr 16–25	Europe	CZ, DE, AT, FR	670	-
Western Canada Freeze	Jan 12–15	N. America	CA	325	-
US January Freeze	Jan 11–14	US	US	1,200	7
Northwest Winter Storm #1	Jan 12–15	US	US	1,550	12
US Jan Polar Vortex	Jan 15–17	US	US	1,250	70
Northwest Winter Storm #2	Jan 16–18	US	US	500	8
Rockies Winter Storm	Mar 11–15	US	US	105	-
Pacific Northwest AR	Nov 19-24	US	US	635	4

Other

Event Name	Date	Region	Countries	Economic Loss	Fatalities
Thailand Heatwave	Jan 1–May 10	Asia	TH	-	61
India Heatwave	Mar 1–Jun 30	Asia	IN	-	374
Myanmar Heatwave	Apr 1–May 3	Asia	MM	-	50
Bangladesh Heatwave	Apr 22–30	Asia	BD	-	15
Japan Heatwave	Apr 29-Sep 30	Asia	JP	-	119+
South Korea Heatwave	Jun 8-Sep 30	Asia	KR	-	32
Pakistan Heatwave	Jun 21–30	Asia	PK	-	568
Europe Summer Heatwave	Jun 1-Sep 30	Europe	IT, DE, ES, FR	-	9,000+
Mexico H1 Heatwave	Mar 17–Jun 30	Latin America	MX	-	172+
Saudi Arabia Heatwave	Jun 14–19	Middle East	SA	-	1,301+
US Summer Heatwave	June 1-Oct 30	United States	US	-	1,000+

Global Natural Catastrophe Economic Losses: 1990-2024

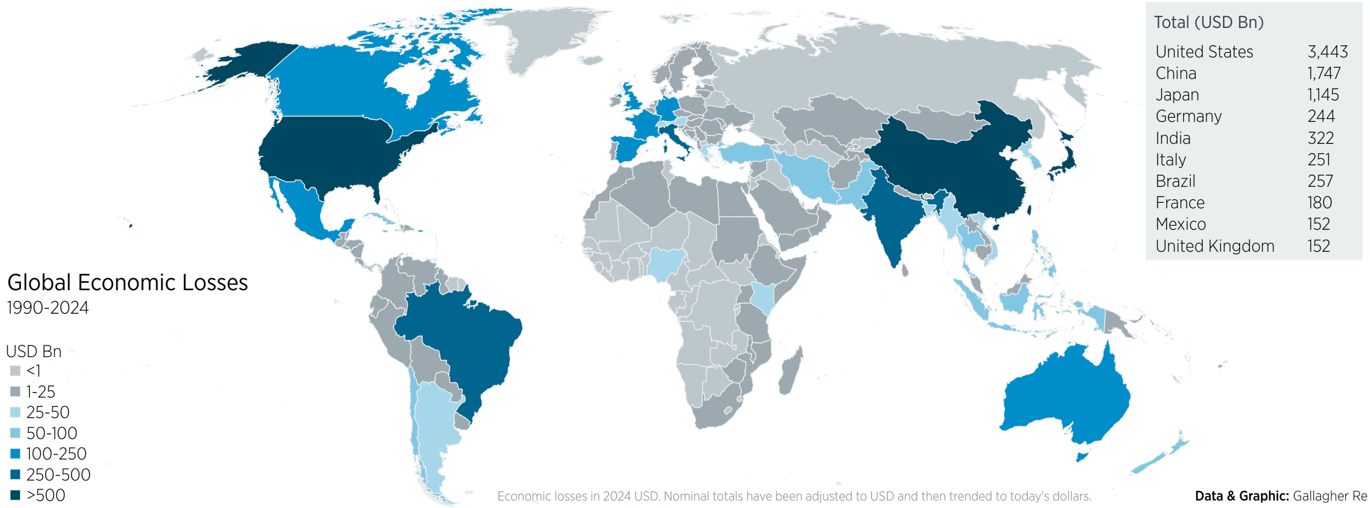


Figure 39: Global map showcasing aggregated economic losses since 1990 | **Data & Graphic:** Gallagher Re

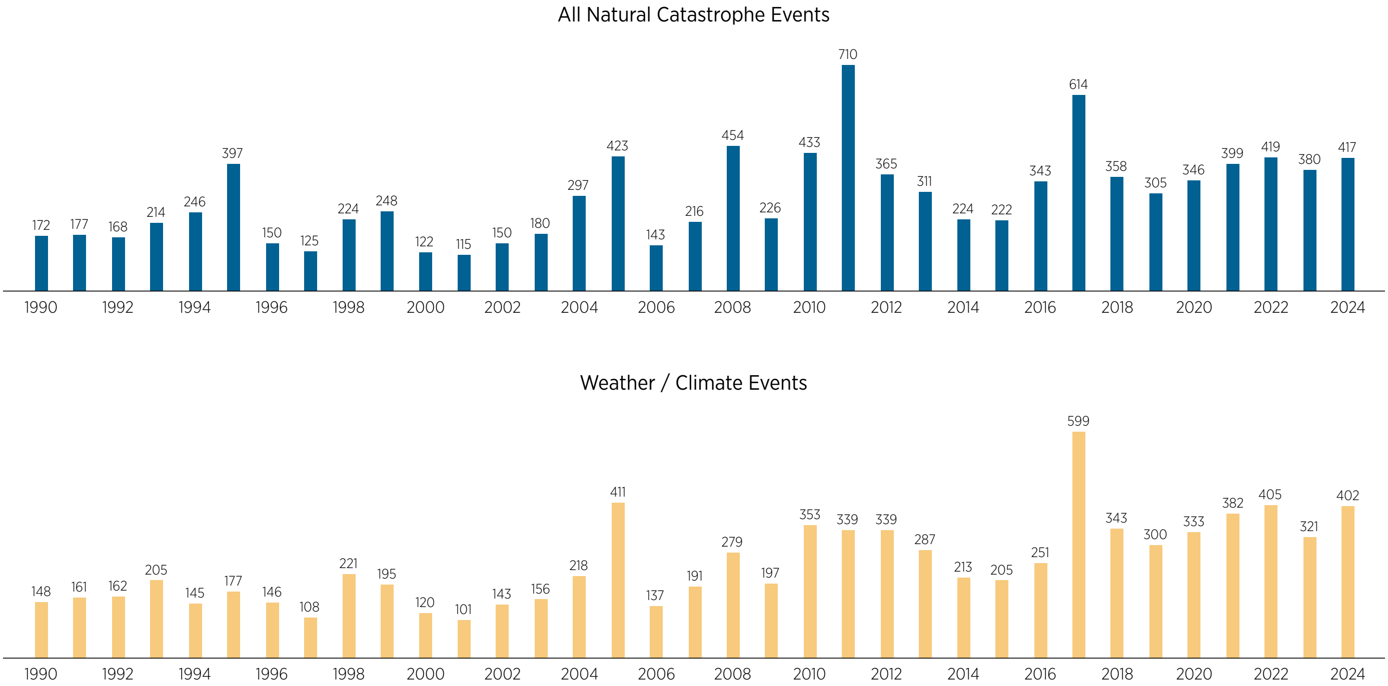


Figure 40: Annual historical natural catastrophe economic losses in 2024 USD billions. Note: Some totals may be rounded | **Data & Graphic:** Gallagher Re

Global Natural Catastrophe Insured Losses: 1990-2024

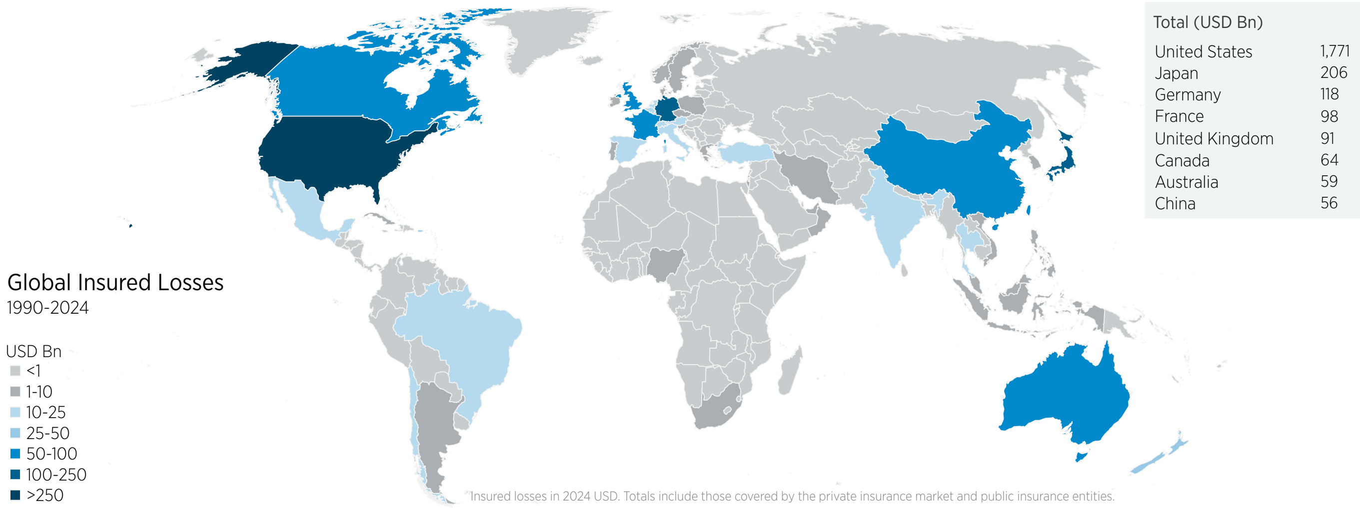


Figure 41: Global map showcasing aggregated insured losses since 1990 | **Data & Graphic:** Gallagher Re

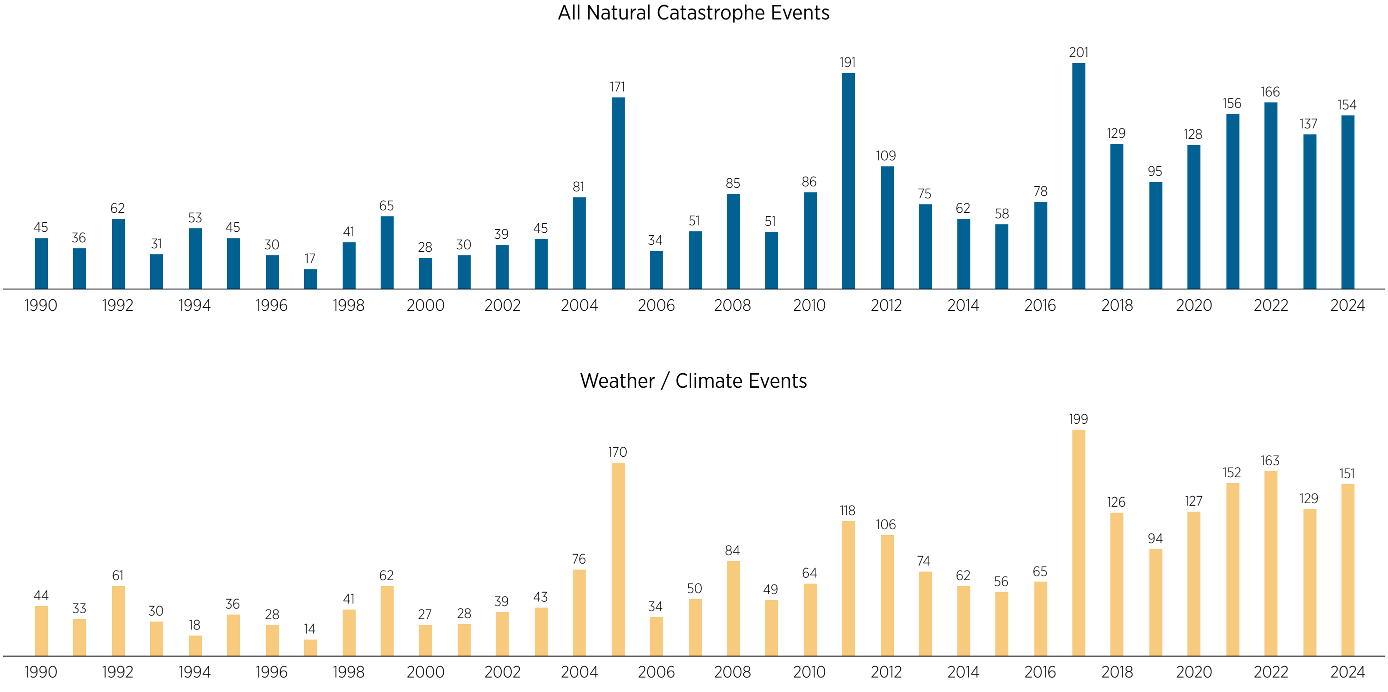


Figure 42: Annual historical natural catastrophe insured losses in 2024 USD billions. Note: Some totals may be rounded | **Data & Graphic:** Gallagher Re

Billion-Dollar Events: Economic & Insured (1990-2024)

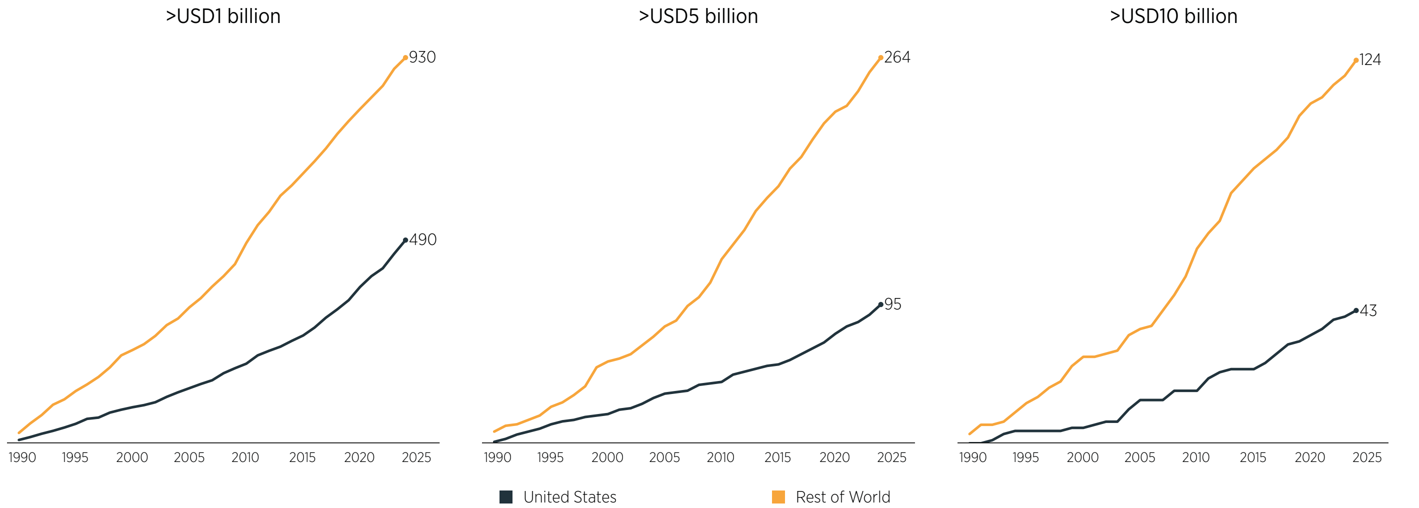


Figure 43: Total number of billion-dollar economic loss natural catastrophes; losses adjusted to 2024 USD | **Data & Graphic:** Gallagher Re

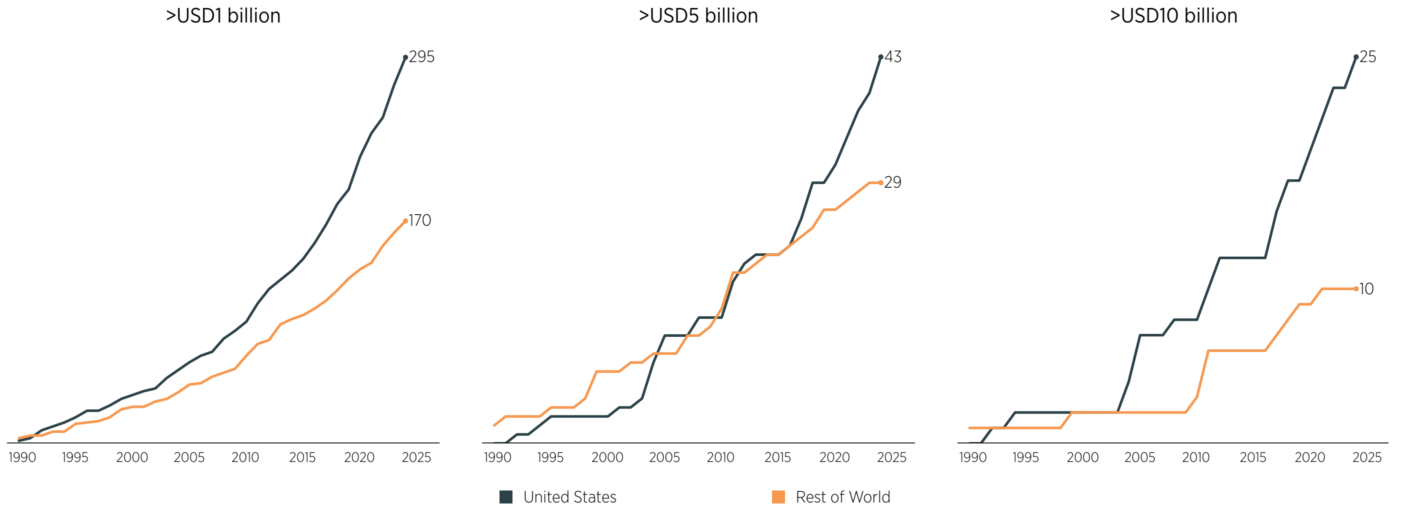


Figure 44: Total number of billion-dollar insured loss natural catastrophes; losses adjusted to 2024 USD | **Data & Graphic:** Gallagher Re

Costliest Natural Catastrophe Events

NOTE: These values included below take the nominal loss from the time of occurrence and adjusted to 2024 USD. The nominal losses, if in a different currency, have been adjusted to USD based on historical conversion rates. Those nominal values were then adjusted to today's dollars using a simple adjustment factor that includes historical US Consumer Price Index and construction/cost of labor indices. Such analysis is meant to solely showcase how actual incurred losses would be quantified today. This is an entirely separate type of analysis compared to normalization, which attempts to take a historical event and create a hypothetical scenario of the same event occurring today with today's population exposure, wealth, inflation, and other socioeconomic factors. Both types of analyses are considered quite useful, but it must be recognized that they are utilized for different purposes.

Event Name	Year	Affected Region (s)	Economic Loss (Nominal)	Economic Loss (2024 USD)
Great Tohoku Earthquake	2011	Japan	235 billion	327 billion
Great Hanshin Earthquake	1995	Japan	103 billion	213 billion
Hurricane Katrina	2005	United States	125 billion	201 billion
Sichuan Earthquake	2008	China	122 billion	172 billion
Hurricane Harvey	2017	United States	125 billion	159 billion
Hurricane Ian	2022	US, Caribbean	115 billion	124 billion
Hurricane Maria	2017	Caribbean, US	90 billion	114 billion
Hurricane Sandy	2012	US, Caribbean	77 billion	105 billion
Hurricane Irma	2017	US, Caribbean	77 billion	98 billion
Northridge Earthquake	1994	United States	44 billion	94 billion
Hurricane Ida	2021	US, Caribbean	75 billion	86 billion
Hurricane Helene	2024	US, Caribbean	78 billion	78 billion
Irpinia Earthquake	1980	Italy	19 billion	68 billion
Thailand Floods	2011	Thailand	45 billion	62 billion
Hurricane Andrew	1992	US, Bahamas	27 billion	61 billion
Yangtze River Basin Floods	1998	China	31 billion	61 billion
Yangtze River Basin Floods	2010	China	39 billion	56 billion
Hurricane Ike	2008	US, Caribbean	38 billion	55 billion
United States Drought	1988	United States	20 billion	54 billion
Bernd (Floods)	2021	Western / Central Europe	47 billion	54 billion

Table 7: Top 20 costliest natural catastrophe events on record by economic loss | **Data & Graphic:** Gallagher Re

Event Name	Year	Affected Region (s)	Insured Loss (Nominal)	Insured Loss (2024 USD)
Hurricane Katrina	2005	United States	65 billion	105 billion
Hurricane Ian	2022	US, Caribbean	55 billion	59 billion
Great Tohoku Earthquake	2011	Japan	35 billion	49 billion
Hurricane Irma	2017	US, Caribbean	33 billion	42 billion
Hurricane Ida	2021	US, Caribbean	36 billion	41 billion
Hurricane Sandy	2012	US, Caribbean	30 billion	41 billion
Hurricane Maria	2017	Caribbean, US	31 billion	39 billion
Hurricane Harvey	2017	United States	30 billion	38 billion
Hurricane Andrew	1992	US, Bahamas	16 billion	36 billion
Northridge Earthquake	1994	United States	15 billion	33 billion
Hurricane Ike	2008	US, Caribbean	18 billion	26 billion
Thailand Floods	2011	Thailand	16 billion	21 billion
Hurricane Helene	2024	US, Caribbean	20 billion	20 billion
Hurricane Milton	2024	US, Mexico	20 billion	20 billion
United States Drought	2012	United States	14 billion	20 billion
Hurricane Wilma	2005	US, Caribbean	13 billion	19 billion
Christchurch Earthquake	2011	New Zealand	13 billion	18 billion
Hurricane Ivan	2004	US, Caribbean	11 billion	17 billion
Polar Vortex; Texas Freeze	2021	United States	15 billion	17 billion
Typhoon Jebi	2018	Japan	14 billion	17 billion

Table 8: Top 20 costliest natural catastrophe events on record by insured loss | **Data & 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 Name	Abbreviation
Macao	MO
Macau	MO
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
Panama	PA
Papua New Guinea	PG
Paraguay	PY
Peru	PE

Country Name	Abbreviation
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 &	QA
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
Swaziland	SZ
Sweden	SE
Switzerland	CH

Country Name	Abbreviation
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
Vatican City	VA
Venezuela	VE
Vietnam	VN
Wallis and Futuna	WF
Western Sahara	EH
Yemen	YE
Zambia	ZM
Zimbabwe	ZW

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