Natural Catastrophe Review: Expert insights, lessons learned and outlook

January — June 2024

wtwco.com

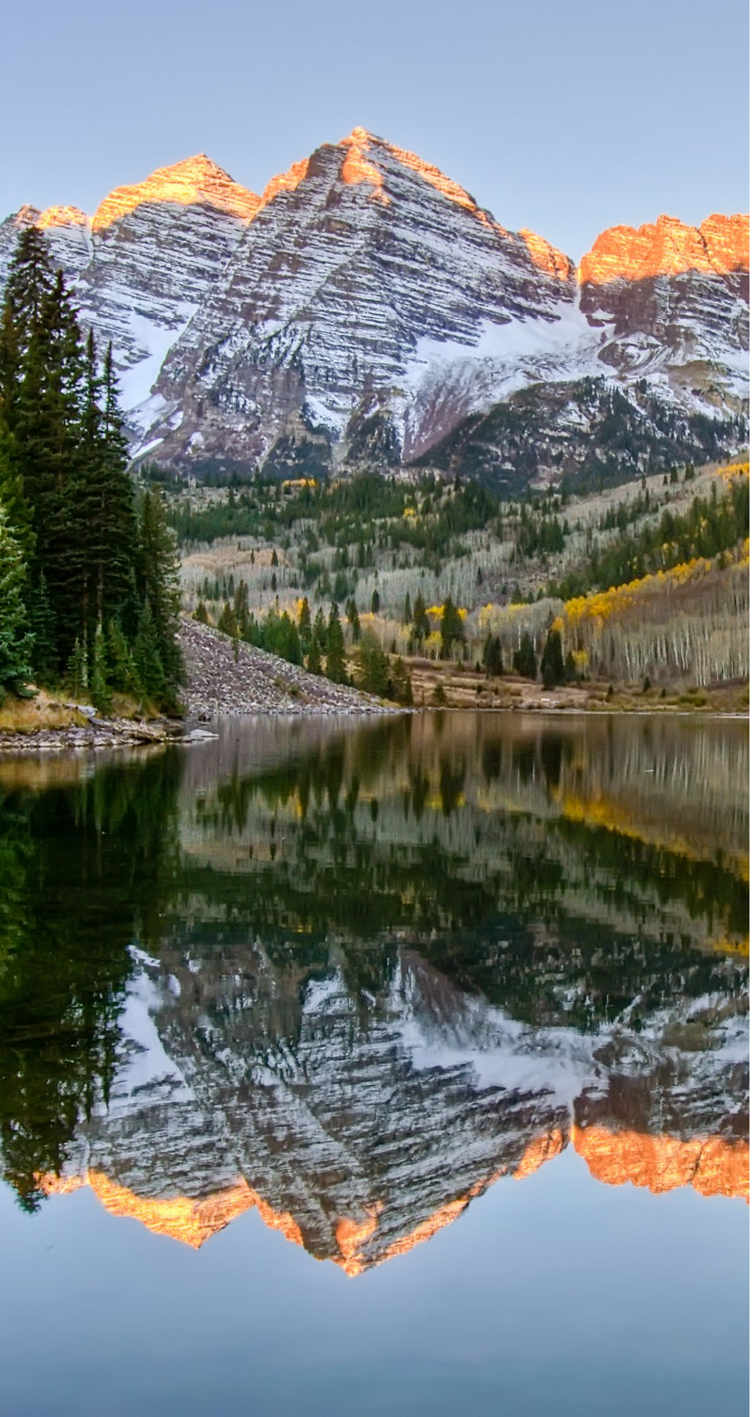


TABLE OF CONTENTS

Foreword

What is the true cost of natural catastrophe risk?

Foreword by Torolf Hamm and Scott St. George

Natural catastrophes amplified by climate change continue to take a bitter toll on the global economy. In 2023, such perils caused more than US $350 billion in economic losses, with insurance covering just over US $100 billion. Catastrophic events in 2024 already include severe convective storms in the U.S., major earthquakes striking Japan and Taiwan, exceptionally intense rainstorms in the Middle East, the largest wildfire ever in Texas' northern Panhandle and severe flooding in southern Germany. More than ever, it's critical to price the cost of natural catastrophe risks accurately and prepare accordingly. But all too often, the naive use of risk models leads people to miscalculate exposure to extreme catastrophic events.

Just three years ago, in July 2021, severe floods devastated several European countries, causing US $54 billion in economic damages and leading to at least 243 deaths. For many businesses, the floods far exceeded their risk scenario planning considerations, with financial impacts much worse than expected. But with access to some of the best meteorological and hydrological data in the world and a mature ecosystem of natural catastrophe models, how could so many misjudge their true exposure to this risk?

Certainly, one reason is that so much rain fell in such a short time. In western Germany, flood levels surged to heights not seen in perhaps 500 or 1,000 years. But the 2021 floods also exposed two critical flaws in the conventional approach to risk. First, even the most sophisticated catastrophe models cannot account for human decisions during a crisis. In 2021, water managers authorized the emergency release of water from reservoirs on several major rivers to prevent catastrophic dam failure, which increased the severity of flooding farther downstream. Second, while catastrophe models help us understand the possible cost of direct damages to physical assets, during the 2021 floods the most significant operational disruptions for many businesses were due to problems with external infrastructure and supply chain breakdowns.

In her book *Escape from Model Land*, WTW Research Fellow Professor Erica Thompson reminds us that models are not just simple tools to be picked up, used and then put down again; instead, the act of modeling should lead us to change the way we think about a situation. At WTW, we support clients embracing a smarter way to risk. Our team goes beyond simplistic risk assessments to help clients work through critical what-if scenarios for catastrophic events for their organization and supply chain. We also combine site-level assessments by our engineers with climate-conditioned catastrophe modeling to build an accurate risk profile that will hold true over the short, medium and long term. The assessment findings are then used to feed into and, where necessary, calibrate the theoretical model.

After any major disaster, it's common for people to complain that their models underestimated the true costs. But it's worth remembering we put our models to work on a very difficult task: to predict the physical and financial impacts of natural hazards on a world constantly being reshaped by climate change, exposure growth and inflation. We should not be surprised if those tools, when used in isolation, do not always provide us with a comprehensive view of risk. WTW believes that expert knowledge and model transparency (avoiding black boxes), in combination with rigorous model evaluation, produce smarter inputs for risk pricing and financing to enable clients to price catastrophe risk correctly — or at least come close.

It is equally important to recognize that interdependencies and operational disruption, owing to wider value chain vulnerabilities, are typically not well captured by natural catastrophe models. In the context of climate change, this can cause potential underestimation of modeled losses. The what-if type of severe event scenario stress testing and boots on the ground catastrophe risk engineering assessment techniques, coupled with actuarial re-simulations of the calibrated loss expectancies, are good ways to enhance the loss perspectives of the natural catastrophe risk models to arrive at a robust and cost-effective risk financing strategy.

Introduction

Introduction

Welcome to the latest edition of WTW's Natural Catastrophe Review, a biannual publication that brings insights from our experts, including the WTW Research Network, to examine recent natural catastrophes, lessons learned and emerging trends.

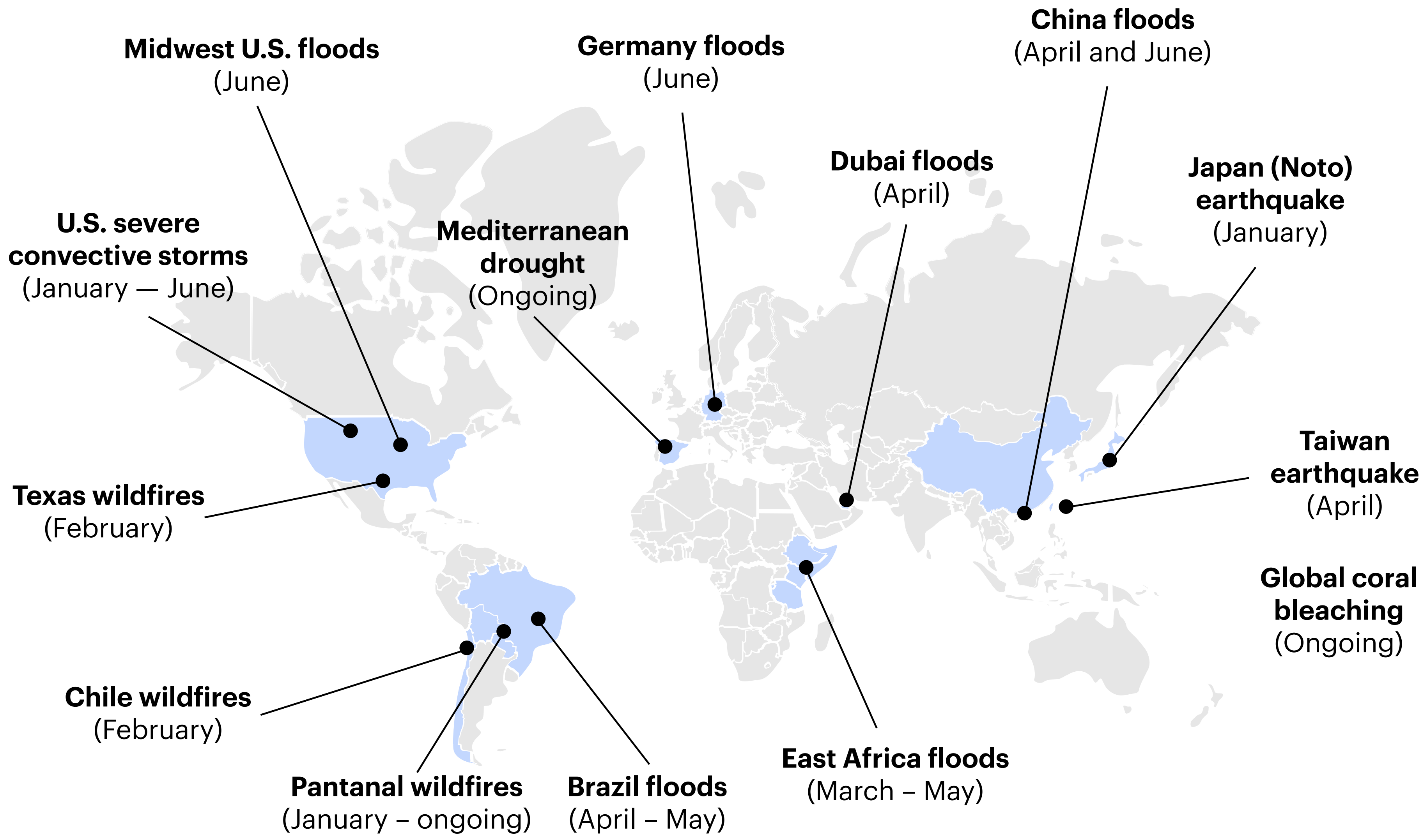
This edition delves into the physical, vulnerability and socioeconomic factors that contributed to the largest natural catastrophes in the first half of 2024 (Figure 1). Offering a smarter way to risk, this report goes beyond the numbers to help you navigate the complex landscape of natural catastrophe and climate risk management.

For the second consecutive year, the U.S. experienced an above-average number of tornadoes, hailstorms and straight-line wind events from January to June, resulting in over US $30 billion in insurance claims.

Severe flooding impacted multiple areas, including Brazil, East Africa, Dubai, Australia, China, the U.S. and Germany. A Mw7.5 earthquake struck Japan, while Taiwan experienced its strongest quake in 25 years, measuring Mw7.4. Marine heat waves triggered a global coral bleaching event, underscoring the importance of protecting "natural capital" ecosystems. Texas recorded its largest wildfire, burning 426,600 hectares. Meanwhile, severe drought in the Mediterranean exposed the vulnerability of food supply chains to climate risks.

In the second half of the year, the focus will shift to the North Atlantic hurricane season, predicted to be exceptionally active due to record-warm sea surface temperatures (SSTs) and the anticipated transition to La Niña (**Section 4.1**). Additionally, this report's Outlook section explores the risk of solar storms as we approach the solar maximum (**Section 4.2**) and provides insights into how organizations can utilize climate risk reporting for strategic planning (**Section 4.3**).

Figure 1. **Prominent natural catastrophes January to June 2024**



U.S. convective storms maintain focus on secondary perils

In **Section 3.1, WTW's Scott St. George** examines the fast start to the 2024 U.S. severe convective storm (SCS) season, which featured violent EF4 tornadoes in Oklahoma and Iowa as well as a derecho in Houston. This follows 2023, a year in which U.S. SCS insurance claims exceeded US $50 billion for the first time. The rising occurrence of "secondary" (or earnings) perils such as SCS, floods and wildfires has prompted insurers to intensify their efforts to better understand and manage these risks. Research plays a crucial role in analyzing these trends. For example, a study by Columbia University, in collaboration with WTW, has found that tornado outbreaks in parts of Alabama, Georgia, Missouri and Mississippi are now more than twice as frequent as they were in the early 1980s.

Increasing flood risks in a changing climate

Flooding is another peril drawing increased attention due to escalating damages. This edition highlights flooding in Dubai (**Section 3.3**), Australia (**Section 3.5**), Brazil (**Section 3.6**) and East Africa (**Section 3.8**). Additionally, flooding resulted in major disruptions and substantial financial losses in China, Germany and the midwestern U.S. (see sidebar). Climate scientists are increasingly linking extreme precipitation events to climate change, which enables the atmosphere to hold more moisture, resulting in heavier rainfall. For instance, researchers have found that human-induced climate change doubled the likelihood of the April to May 2024 flooding in Brazil.[1]

Earthquake engineering lessons

In early 2024, major earthquakes struck Japan and Taiwan. Improved resilience and preparedness measures significantly reduced human casualties and damage; however, some building and infrastructure failures still occurred. In **Section 3.2, WTW's Arash Nassirpour, Elide Pantoli** and **James Dalziel** explain that in Japan, most failures were concentrated in areas prone to liquefaction, while in Taiwan, soft-story collapse was the primary issue. These problems highlight the ongoing need for comprehensive seismic risk assessments, retrofitting vulnerable structures and updating construction practices and codes.

Drought-induced risks in food supply chains

In **Section 3.7**, an article by **WTW's Neil Gunn** and co-authors discusses the impact of a prolonged drought in the Mediterranean region on agricultural production, focusing on the olive industry. The drought, caused by meteorological and hydrological factors, led to impaired crop yields and a 2.5-fold increase in olive oil prices, highlighting the vulnerability of food supply chains to climatic disruptions. With climate change predicted to increase drought risk in many parts of the world, businesses are advised to adopt effective strategies to assess and mitigate potential drought-related impacts on their operations and supply chains.

Infrastructure vulnerabilities

Several events in 2024 have demonstrated the importance of resilient infrastructure amid rising climate-related catastrophes. In **Section 3.4**, an article by **Chloe Campo** and **Guy Schumann** from **RSS-Hydro** highlights how Texas' aging and poorly managed electricity infrastructure ignited the Panhandle fires. In Brazil, catastrophic flooding was likely exacerbated by the inadequate maintenance of flood protection systems. And flooding in Dubai showcased the significant impact natural catastrophes can have on airport infrastructure.

Businesses can manage these systemic risks through comprehensive risk assessments and such tools as WTW's Airport Risk Index. Also effective are storylines — physically consistent narratives of plausible future events. In **Section 3.5, WTW's Ben Rabb**, **Anna Haworth** and **Jessica Boyd** discuss how storylines can help businesses understand and navigate complex risks, such as infrastructure disruptions, in the face of climate change.

[1] World Weather Attribution. Climate change made the floods in southern Brazil twice as likely. (2024).

Record-breaking temperatures continue

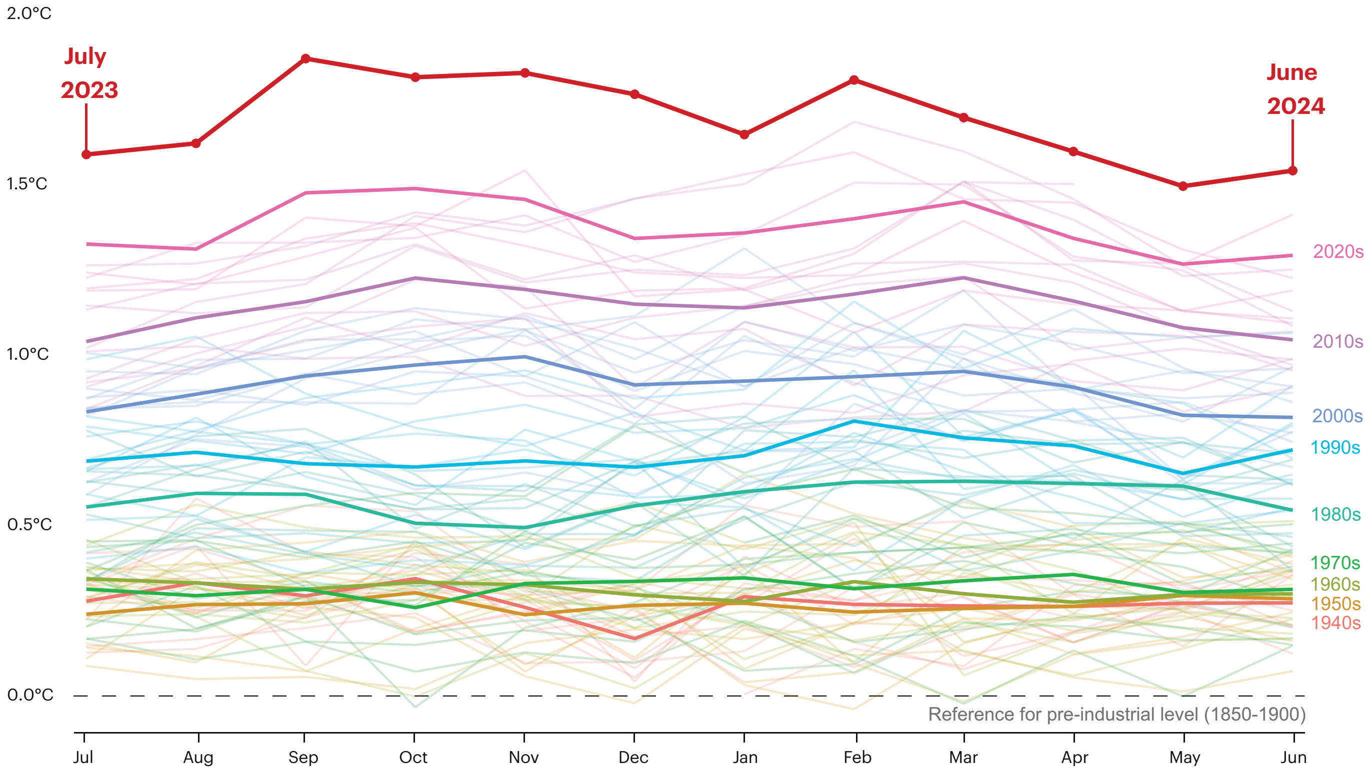
June 2023 to June 2024 brought 13 consecutive months of record-breaking global average temperatures with each month surpassing the previous records for that time of year (Figure 2). According to the Copernicus Climate Change Service, the global average temperature during the past 12 months (July 2023 to June 2024) was 1.6°C above the 1850 – 1900 pre-industrial average. Additionally, global SSTs set records for 15 consecutive months up to June 2024. In **Section 3.9**, **WTW's Sarah Conway** and **Jamie Pollard** detail how high SSTs have led to a global coral bleaching event and discuss the role of parametric insurance in protecting these vulnerable ecosystems.

Transition from El Niño to La Niña

The El Niño-Southern Oscillation (ENSO) is a climate pattern characterized by periodic fluctuations in Pacific Ocean SSTs. El Niño features warmer SSTs in the central and eastern tropical Pacific, while La Niña brings cooler waters. ENSO affects global weather patterns and contributed to record-breaking global temperatures in 2023.[2] However, by early 2024, El Niño conditions waned, transitioning to the current ENSO-neutral state.

Forecasts indicate a 65% chance of La Niña developing in July to September and an 85% chance of it persisting into November to January.[3] La Niña typically leads to more hurricanes in the North Atlantic by creating calmer upper-level winds that allow storms to form more easily. Coupled with record-warm SSTs, this has led to predictions of an exceptionally active 2024 North Atlantic hurricane season. In **Section 4.1**, **James Done** from the **National Center for Atmospheric Research** discusses these forecasts and their implications.

Figure 2. **Monthly average global surface air temperature anomaly for each year 1940 – 2024 (pale lines) relative to a pre-industrial baseline of 1850 – 1900 (dashed line), decade averages (solid lines) and the last 12 months (solid red line).**



Data source: Copernicus Climate Change Service via climatereanalyzer.org.

[2] WTW. WTW Natural Catastrophe Review July – December 2023
[3] Climate Prediction Center. ENSO: Recent Evolution, Current Status and Predictions. (2024)

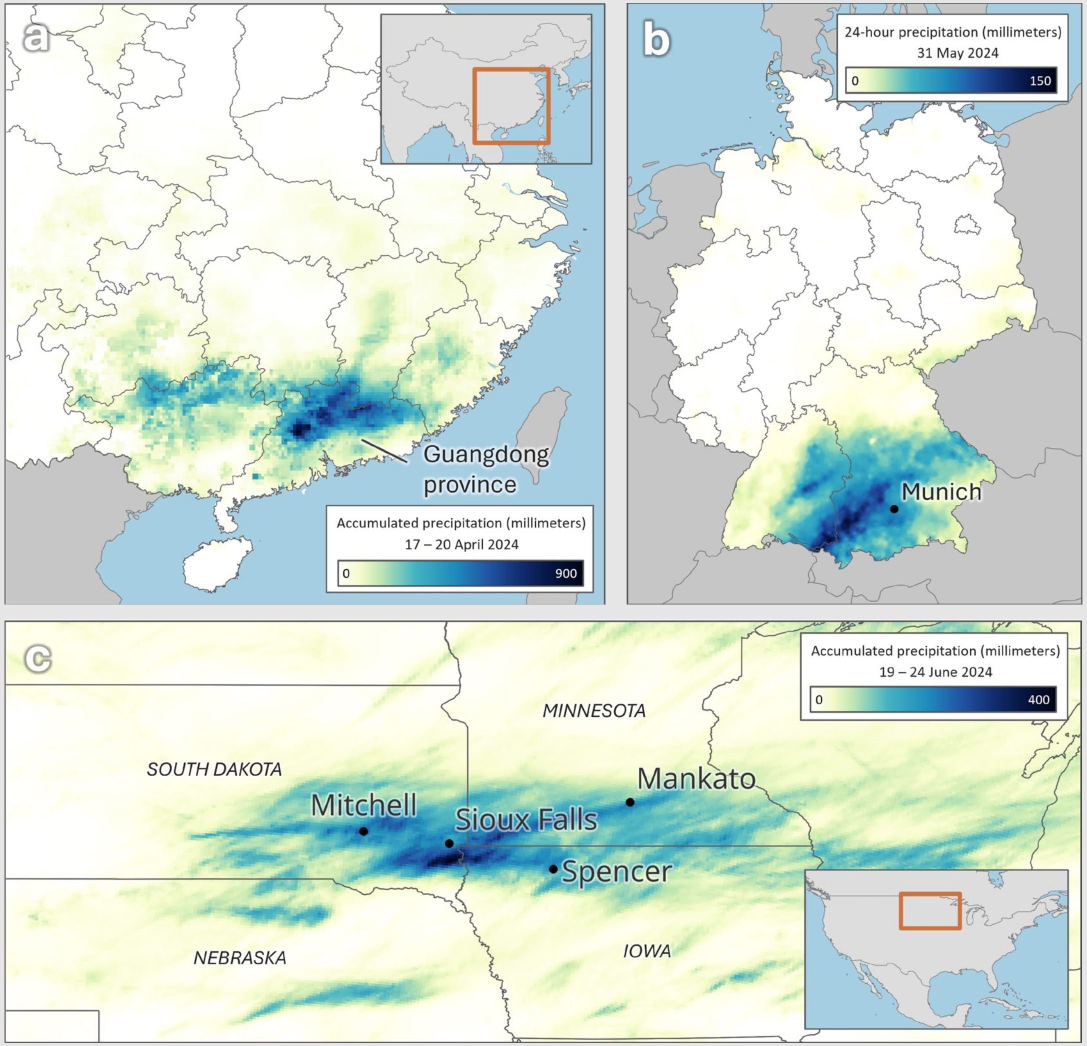
Flooding in China, Germany and Midwest U.S.

In April 2024, intense rainfall over large parts of southern China caused severe flooding that displaced thousands and caused extensive damage to infrastructure, particularly in Guangdong province (Figure 3a).[4] Additional flooding occurred in southern China in late June, with Fujian province most severely affected.

At the end of May and into early June, southern Germany experienced unprecedented flooding and landslides, caused by intense rainfall over a wide area (Figure 3b).[5] Further flooding occurred further downstream in the Danube river catchment in Austria and Hungary.

In June, torrential rains led to devastating flooding over the Midwest U.S., with the Mississippi and Missouri rivers bursting their banks. Iowa was worst affected, but flooding also occurred in South Dakota, Minnesota and Nebraska (Figure 3c).[6]

Figure 3. **Flooding in China, Germany and Midwest U.S.**



Contacts

Cameron Rye
Head of Modelling Research and Innovation,
WTW Research Network
cameron.rye@wtwco.com

[4] NASA-GPM. Daily precipitation data. (2024)
[5] DWD. Daily precipitation data. (2024)
[6] NOAA. Quantitative precipitation estimate (QPE) data. (2024)

Natural peril review

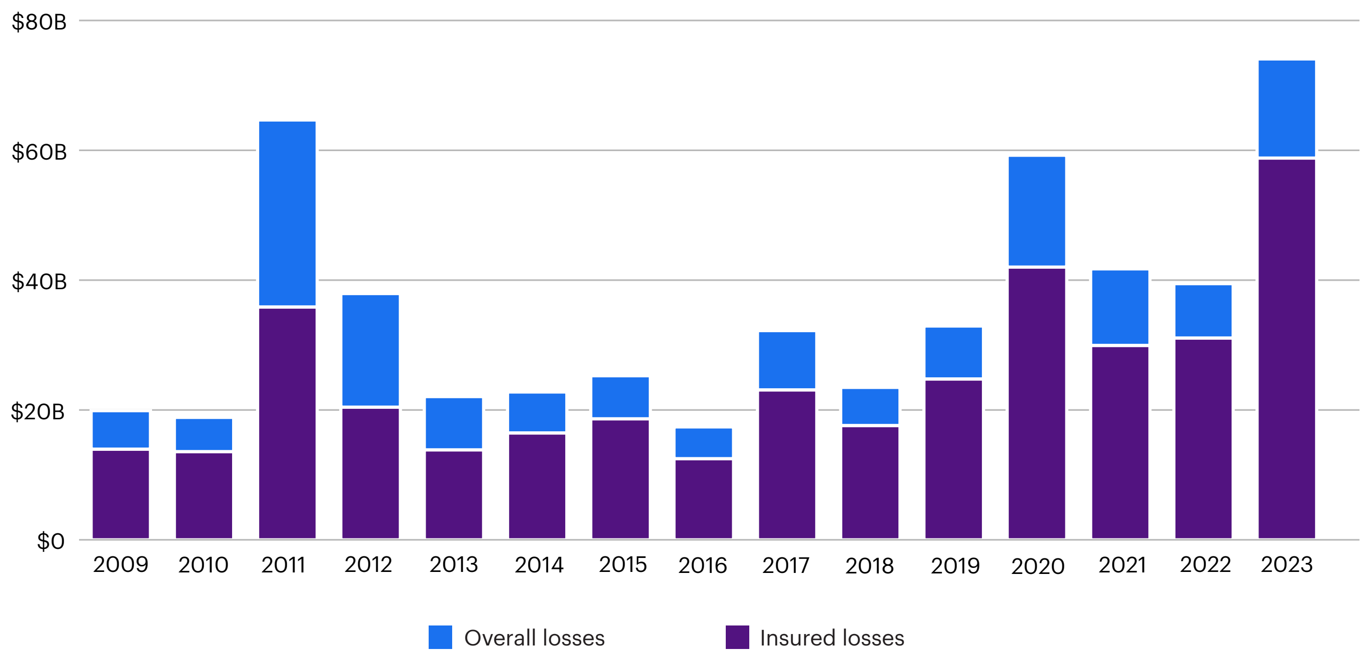
3.1 An unwelcome fast start to the U.S. severe weather season

Severe storms have set a fast pace for the first half of 2024. Will exposure growth and climate change combine to produce another year of high losses from convective storms?

For the United States, summer isn't even in full swing yet, and it's already been an extremely active year for severe convective storms.[1] To date, 2024 has the second-highest number of tornado reports (1,264) of any year in the past 15 years. We've also seen very high numbers of hailstorms (4,108 — the fifth most active year) and damaging windstorms (8,978 — the second most). Fortunately, this year still lags well behind the pace set in 2011, which remains the worst year on record for all three perils across the U.S.

Total storm counts for the entire country are an imperfect proxy for economic or insured losses. In 2011 and again in 2023, high numbers of wind and hailstorms added up to the worst years for direct damages in recent memory (Figure 1). On the other hand, although 2020 was a typical year with respect to tornado and windstorm numbers (and with a lower-than-average number of hailstorms), economic and insured losses were still high. But because most damaging storms happen in summer, our early start to the severe weather season may portend yet another costly year with high damages from convective storms.

Figure 1. **Total insured and overall economic losses (in U.S. billions) due to severe convective storms in the U.S. from 2009 to 2023. Amounts are adjusted to 2024 dollars using the Consumer Price Index from the U.S. Bureau of Labor Statistics.**



Data source: The Insurance Information Institute.

[1] NOAA Storm Prediction Center. Severe Weather Maps, Graphics, and Data Page. (2024).

Major storms so far in 2024

This year's strongest storms have been associated with tornado "outbreaks," which occur when multiple tornadoes spawn from the same large-scale weather pattern over one or more days. From April 26 to 28, severe weather over the Southern and High Plains generated more than 140 tornadoes, including a violent (intensity EF4) tornado that destroyed a Dollar Tree distribution warehouse in Marietta, Oklahoma. Another large outbreak from May 6 to 10 saw more than 160 tornadoes hit Oklahoma, Kansas, Tennessee, Alabama, Georgia and Michigan. That system was so destructive that several National Weather Service offices took the unusual step to issue tornado "emergencies" (situations where a severe threat to human life is imminent or ongoing). Finally, from May 19 to 27 the Midwest experienced an extended period of tornadic activity that culminated with a large, violent EF4 tornado that devastated Greenfield, Iowa, and killed at least five people.

But wind speed is not the only factor that determines if extreme weather will cause high damages. The derecho that struck the Gulf Coast on May 16 and 17 had winds that peaked at just over 100 miles per hour (160 kilometers per hour), equivalent to a moderate (EF1) tornado. But because this system passed directly through downtown Houston, it produced widespread and significant damage. Described as the most destructive wind event to affect the city in a generation, the derecho blew out windows of many high-rise windows, damaged electrical transmission lines and caused the deaths of at least eight people.

The subtle hand of climate change?

Based on our understanding of how severe convective storms form and grow, we might expect a warmer world to also be a stormier one. In order to produce a thunderstorm, the atmosphere needs to have three main ingredients: sufficient moisture, strong updraft, and a strong change of wind speed or direction with height. Climate model simulations suggest, under various warming scenarios, the U.S. will experience stronger updrafts, which would lead to more favorable environments for the genesis of severe thunderstorms.[2] But in its latest report, the Intergovernmental Panel on Climate Change states there is low confidence in past trends in hail and winds and tornado activity. Why is it so hard to know whether severe convective storms have become stronger or more frequent?

Part of the reason we struggle to understand long-term trends in tornadoes, hailstorms and damaging windstorms is because the most severe storms are rare. More tornadoes affect the U.S. than any other country worldwide. But since 1950, only 59 tornadoes have been formally rated as catastrophic (EF5) — fewer than one per year. It's also been more than a decade since the most recent EF5 event, the 2013 Moore tornado that destroyed more than 1,100 homes in Oklahoma. It's fortunate the most violent storms are few and far between, but their low numbers make it challenging to apply standard statistical approaches to determine whether or not they are becoming more common.

In order to tease out subtle but important changes in the risk of severe convective storms, WTW has partnered with Columbia University's Department of Applied Physics and Applied Mathematics to investigate current and future trends in tornado behavior. In a recent study published by the *Monthly Weather Review*, our partners Dr. Kelsey Malloy and Prof. Michael Tippett developed a new risk index to calculate the probability of a tornado outbreak based on large-scale weather patterns.[3] By combining their index with on-the-ground storm reports, they were able to demonstrate that, in parts of Alabama, Georgia, Missouri and Mississippi, today tornado outbreaks are more than twice as frequent as they were in the early 1980s.

[2] Brooks, H.E. Severe thunderstorms and climate change. *Atmospheric Research* 123, 129-138 (2013).
[3] Malloy, K, Tippett, M.E. A stochastic statistical model for U.S. outbreak-level tornado occurrence based on the large-scale environment. *Monthly Weather Review* 152 (5), 1141-1161.

Tornado risk solutions from WTW

By leveraging the latest scientific evidence in our risk models and risk consulting, clients of WTW's Climate Practice benefit from advanced, quantitative insight able to underpin a smarter, forward-looking approach to managing tornado risk — both to their own facilities and across the value chain. Starting with an initial assessment of tornado exposure using Global Peril Diagnostic, WTW's cross-disciplinary solutions — spanning risk engineering, climate science and Enterprise Risk Management — are designed to provide clients the insight necessary to inform risk management decisions that enhance their resilience.

Implications for risk managers

Risk assessment and mitigation
Perform comprehensive assessments of exposure to severe weather events, particularly tornadoes, hail and straight-line wind. Use advanced risk models and the latest scientific discoveries to inform mitigation strategies and enhance resilience.

Climate change research
Incorporate climate change research findings into risk management. Update estimates of the frequency and severity of severe thunderstorms to improve planning, preparedness and risk management.

Risk management and transfer
Partner with natural catastrophe risk specialists to develop solutions for managing and transferring the increasing risks from severe weather in the U.S. and elsewhere.

Contacts

Scott St. George
Head of Weather and Climate Research,
WTW Research Network
scott.stgeorge@wtwco.com

3.2 Engineering lessons from the 2024 Noto (Japan) and Hualien (Taiwan) earthquakes

In early 2024, major earthquakes struck Japan and Taiwan. WTW's engineering experts examine the reasons behind building failures, highlighting the ongoing need for seismic risk assessments, retrofitting and improved construction codes.

In the first half of 2024, significant earthquakes struck Japan (Mw7.5) and Taiwan (Mw7.4). Improved resilience and preparedness reduced human casualties and damage compared with past events, but building and infrastructure failures still occurred. In Japan, most failures were in liquefaction-prone areas, while in Taiwan, soft-story collapse was the primary cause. These issues highlight the ongoing need to undertake seismic risk assessments, retrofit vulnerable buildings and update construction practices and codes.

Mw7.5 Noto earthquake, Japan

On New Year's Day 2024, a Mw7.5 earthquake struck Japan's Noto peninsula at a depth of 10 kilometers, causing severe shaking, liquefaction and landslides. The shallow epicenter produced peak ground accelerations (PGAs) of up to 1.2g (gravitational acceleration; 9.81 m/s^2), comparable to those felt during the 2011 Tohoku earthquake. Over 102,000 structures were damaged in Ishikawa Prefecture, including the complete or partial collapse of 23,700 buildings. The event resulted in 245 deaths and over 1,300 injuries, primarily from collapsed buildings. The Cabinet Office of Japan estimated economic losses at up to 2.6 trillion yen (US $17.6 billion), while insured losses are estimated at up to 870 billion yen (US $5.5 billion).[1,2]

Despite frequent seismic activity, Japan experiences fewer earthquake casualties than many other countries due to its strict building codes, which are continuously updated after major seismic events. Established after the 1923 Yokohama earthquake, these codes mandate stringent seismic design and retrofitting. The 1995 Kobe and 2011 Tohoku earthquakes prompted further improvements to the Building Standard Law, enhancing seismic resilience. In response to the 1995 Kobe earthquake, Japan also implemented an early warning system and conducts regular earthquake drills to improve public preparedness and response.

Modern Japanese buildings, utilizing reinforced concrete, steel, seismic dampers and base isolation, generally withstood the earthquake well, showing minimal structural damage. Collapses were mainly seen in older structures, those with irregular designs or those with inadequate seismic detailing, particularly in liquefaction zones. Notably, some newly constructed wooden buildings also failed, suggesting a need for further revisions to the Building Standard Law.

Liquefaction and landslides were widespread, causing significant damage. Around 30% of buildings in areas affected by liquefaction experienced differential settlement, tilting and collapse due to soil-bearing capacity loss. Earthquake-triggered landslides worsened the destruction, blocking key roads and hindering rescue and relief efforts.[3]

The earthquake also severely affected infrastructure, damaging 120 kilometers of roads (Figure 1).[4] Power plants, including nuclear facilities, were closely monitored and experienced minor damage and temporary shutdowns, but overall, the power infrastructure performed satisfactorily. Internet access and data centers faced temporary outages, but redundancy and swift responses from service providers quickly restored connectivity.

1 Japanese Red Cross (JRC). Operation Update No.30: 2024 Noto Peninsula Earthquake: The Japanese Red Cross Society's Response. (2024).
2 Yonetani, Y. Damage from Noto earthquake estimated to hit 2.6 trillion yen. (2024).
3 National Research Institute for Earth Science and Disaster Resilience (NIED). Damage Assessment Report: The 2024 Noto Earthquake. (2024).
4 Japan Meteorological Agency (JMA). The 2024 Noto Earthquake: Seismic Activity and Ground Motion. (2024).

Despite improvements in building design and preparedness in recent decades, the Noto earthquake highlights the need for further hazard assessment and mitigation. This includes better understanding of liquefaction and landslide susceptibility, improving critical infrastructure resilience, promoting earthquake insurance, prioritizing seismic retrofitting, and investigating the seismic performance of new and existing buildings.

Figure 1. **Aftermath of the 2024 Noto earthquake, northwest of Tokyo. The powerful quake severely cracked roads and caused heavy damage to infrastructure, leading to massive disruption in emergency response.**

Source: AP Photo/Hiro Komae.

Mw7.4 Hualien earthquake, Taiwan

A powerful Mw7.4 earthquake struck eastern Taiwan on April 3, 2024, 18 kilometers southwest of the city of Hualien at a depth of 34.8 kilometers. The relatively shallow depth produced intense shaking, with a highest PGA of 0.55 g near the epicenter.[5] The Land Management Agency reported 848 cases of damaged structures, 42 of which were listed as “code red.” The disaster resulted in 18 deaths and over 1,100 injuries. Economic losses were estimated at US $28 billion, with insured losses likely between US $0.5 billion and $1 billion.

This was the island’s strongest earthquake in nearly 25 years, following the 1999 Mw7.7 Chi-Chi event in central Taiwan that caused severe damage or collapse to more than 100,000 buildings and resulted in over 2,400 fatalities and 11,000 injuries.

The dramatic contrast in the number of collapsed buildings and fatalities between the 1999 Chi-Chi event and recent earthquakes highlights the significant improvements in seismic resilience in the past three decades.

After the 1999 earthquake, Taiwan introduced stringent construction standards, and poor construction practices were curbed. Recognizing that improving building codes alone is insufficient, Taiwan also implemented programs to assess and retrofit structures. For example, after many schools were damaged or destroyed in the Chi-Chi earthquake, US $4 billion was allocated from 2009 to 2022 to upgrade the seismic capacity of 10,000 schools.[6] Additionally, private buildings underwent screenings and mandatory seismic assessments, with the government providing retrofit guidance and subsidies for high-risk buildings.[7]

Despite these retrofit efforts, some buildings remain at high risk of seismic damage. The Hualien earthquake once again highlighted the vulnerability of soft-story buildings — multi-story structures with open spaces lacking structural walls, common in buildings with carports or commercial spaces on the first floor.

Soft-story collapses in the recent event occurred on high-rise reinforced concrete structures. These buildings became common in cities following Taiwan’s 1984 “Open Space” policy, which permitted vertical construction in congested cities if the street-level story was open. This design results in low stiffness on the first floor, causing earthquake-induced drifts to concentrate there, creating significant stresses and potential failure. Typically, the upper part of the building, which remains relatively intact, collapses onto the soft story, as seen in recent Hualien incidents (Figure 2).

[5] USGS. (2024).
[6] Hwang, S.J. Seismic retrofitting for school buildings in Taiwan. (2023).
[7] Department of Information Services. Nationwide seismic assessment and retrofit program. (2019).

Figure 2. **Photograph of the Uranus building, which partially collapsed during the Hualien earthquake likely due to a soft-story failure.**

Source: Shufu Liu/ROC Office of the President/Alamy Live News.

Soft-story buildings are an issue not only in Taiwan but also in other seismically active regions such as California. For example, the 1989 Loma Prieta earthquake in Northern California caused many failures of soft-story multi-residential buildings with carports on the ground floor.[8] This common vulnerability across continents highlights the importance of a comprehensive risk evaluation performed by teams of experienced engineers, who not only can assess the risk but also can provide viable retrofit strategies for a vast array of structures.

Implications for risk managers

Risk assessment and mitigation

Identify high-risk assets through screening portfolios and operations. Conduct comprehensive seismic risk assessments of these sites to detect vulnerabilities such as soft-story buildings, liquefaction and landslide risks. Prioritize retrofitting older structures and ensure new buildings comply with current seismic standards. Utilize state-of-the-art seismic detailing for structural and non-structural components, even when not mandated by seismic codes.

Infrastructure impact analysis

Ensure disaster recovery plans address earthquake impacts on key infrastructure, such as roads, power stations and internet service providers. Insurers should integrate these considerations into their risk models.

Risk management and transfer

Partner with natural catastrophe risk specialists to develop innovative solutions for managing and transferring seismic risks and enhancing resilience.

Contacts

Arash Nassirpour
Senior Associate, Natural Catastrophe & Climate Risk Management
arash.nassirpour@wtwco.com

Elide Pantoli
Lead Associate, Natural Catastrophe & Climate Risk Management
elide.pantoli@wtwco.com

James Dalziel
Earth Risk Research Lead,
WTW Research Network
james.dalziel@wtwco.com

[8] Dal Pino, N. & Enright, S. Structural Considerations for Earthquake-Resistant Design. (2019).

3.3 Building aviation resilience amid increasing flood risks and climate challenges

The recent floods in Dubai caused significant challenges for local airlines and airports. Well-calibrated insurance and risk management strategies, including the use of parametric insurance, can improve resilience.

Floods have always been part of life on earth, but recent flash flooding events in eastern Australia,[1] Brazil,[2] Dubai[3] and Texas[4] have been significant, sudden, and caused major disruption for airports and airlines. Changes in the world's climate are making these previously unusual events into something we all need to be prepared for. Insurance and risk management have a positive role to play in supporting aviation organizations as they strive for resilience.

Dubai's deluge in April was particularly eye-catching because it occurred in a region that is famously arid. The United Arab Emirates (U.A.E.) has minimal annual rainfall, typically 78 millimeters per year (compared with the U.K.'s 1,220 millimeters),[5] and extreme rainfall events are rare in the region. When they do occur, they are often intense, and what is concerning is that records related to the intensity of rainfall in the region that were broken in 2022 have been broken again less than two years later.[6]

An estimated 1,244 flights were canceled over the initial two days of the incident,[7] which likely resulted in subsequent delays and cancellations throughout global networks. Business interruption insurance typically requires physical damage for a payout, and since there was little to no physical damage to aircraft, many incurred costs are unlikely to be recoverable from insurers.

1 BBC. Queensland floods: Airport submerged and crocodiles seen after record rain. (2023).
2 The Wall Street Journal. Watch: Airport Submerged by Flood Waters in Southern Brazil. (2024).
3 CNN. Dubai flights canceled, schools and offices shut as rain pelts UAE just weeks after deadly floods. (2024).
4 CNN. 'Nightmare scenario' forecast calls for significant flooding in already-soaked Texas and Gulf Coast states. (2024).
5 The World Bank. Average precipitation in depth – United Arab Emirates, United Kingdom. (2020).
6 Terry, J. P., et al. The rain deluge and flash floods of summer 2022 in the United Arab Emirates: Causes, analysis and perspectives on flood-risk reduction. Journal of Arid Environments, 215, 105013. (2023).
7 NDTV. Slow Recovery As Dubai Airport, Roads Still Plagued By Floods. (2024).

Insights from WTW's Airport Risk Index

According to data collated from WTW's Airport Risk Index (ARI), which leverages scientific analysis from 110 global airports to explore extreme threats faced today, intense rainfall events and flooding pose a credible threat to operators in the Middle East, despite the generally arid climate. Other familiar environmental threats such as heat waves are also significant concerns.

For airports in the Middle East, the ARI's data on flooding scenarios show that returning to normal operating conditions could take anywhere from 11 days to a full year. This depends on the severity of the scenario, operator resilience and vulnerability characteristics. Airports that have not recently faced a flooding event should assess and enhance their resilience to these disruptions.

The ARI uses historical precedents and research to create 66 scenarios, each depicting a different level of impact and likelihood. This allows airports to stress test their assumptions and identify potential vulnerabilities. Although the ARI model isn't a definitive indicator, and not all operators in the Middle East will experience every scenario, the ARI serves as a useful tool for comparative analysis and resilience planning.

By understanding these scenarios, airport operators can conduct site-specific investigations to enhance airport resilience, tailor their insurance coverage to realistically reflect actual flood risks and prepare for future disruptions from climate risks. Having a clear picture of current risks is essential for understanding how events might change in the future and for ensuring operational dependability.

What has caused the recent flooding in Dubai?

The 2024 rainfall event in Dubai, the heaviest in 75 years, while extreme, is not entirely unprecedented. The region experienced a similar rainfall event in 2022. Extreme rainfall events in the U.A.E. are typically associated with mesoscale convective systems, which are large, organized groups of thunderstorms that can produce heavy rainfall over extended periods. Climate change is increasing the severity of these systems, making the rainfall within them more intense and longer lasting, as a warmer atmosphere holds more moisture. This trend indicates that the Middle East should prepare for more disruptions as the climate continues to change.

Rapid urbanization exacerbates this issue, with 85% of the U.A.E.'s population living in flood-prone areas.[8] Urbanization is creating a similar story in many parts of the world.[9,10] Areas that would have previously been naturally available for water to be contained within and absorbed into have now been built on.

To mitigate these risks, investment in engineered solutions — such as improved drainage, land use planning, community resilience measures, and enhanced forecasting and early warning systems — is necessary.

Adapting to climate risks with parametric insurance and robust partnerships

Parametric insurance or index-based programs can support aviation organizations facing rain-related cancellations in arid regions and other diverse, changing landscapes. These programs address income loss or increased costs from adverse weather using robust data to tailor coverage based on geography, risk exposure, risk appetite and budget. They cover various weather events, including tropical cyclones, floods (river, coastal and flash flooding), wildfires, drought, hail and temperature extremes. Claims are triggered if a reference index moves above (or below) an agreed threshold, with payouts calculated on a pre-agreed scale.

The benefits of parametric insurance for aviation organizations are significant. It provides protection against economic loss without requiring direct damage to insured assets, thereby covering non-damage business interruption. Payouts can be scaled and tailored to provide coverage for specific scenarios and event intensities. The clearly defined parameters eliminate the need for onsite loss adjustment, allowing claims to be paid within days or weeks rather than months.

[8] World Weather Attribution. Heavy precipitation hitting vulnerable communities in the UAE and Oman becoming an increasing threat as the climate warms. (2024).
[9] WTW. A view of catastrophic flooding from across the world. (2023).
[10] WTW. Emilia-Romagna floods: a product of urbanization and climate change. (2023).

With unrestricted use of claim proceeds, organizations can use payments as needed, whether to replace damaged assets; supplement revenue; cover additional expenditures; invest in risk management; service debt; or provide financial support for customers, employees or communities.

The recent floods in Dubai and further afield highlight the importance of strong relationships with insurance partners to ensure that risk management and financing meet the evolving needs of aviation organizations. Accurate risk assessment models that incorporate changing climate conditions and urban development patterns are crucial. While historical data are useful, preparing for future changes, and being ready for change, is essential for building resilience.

Implications for risk managers

Risk assessment and mitigation

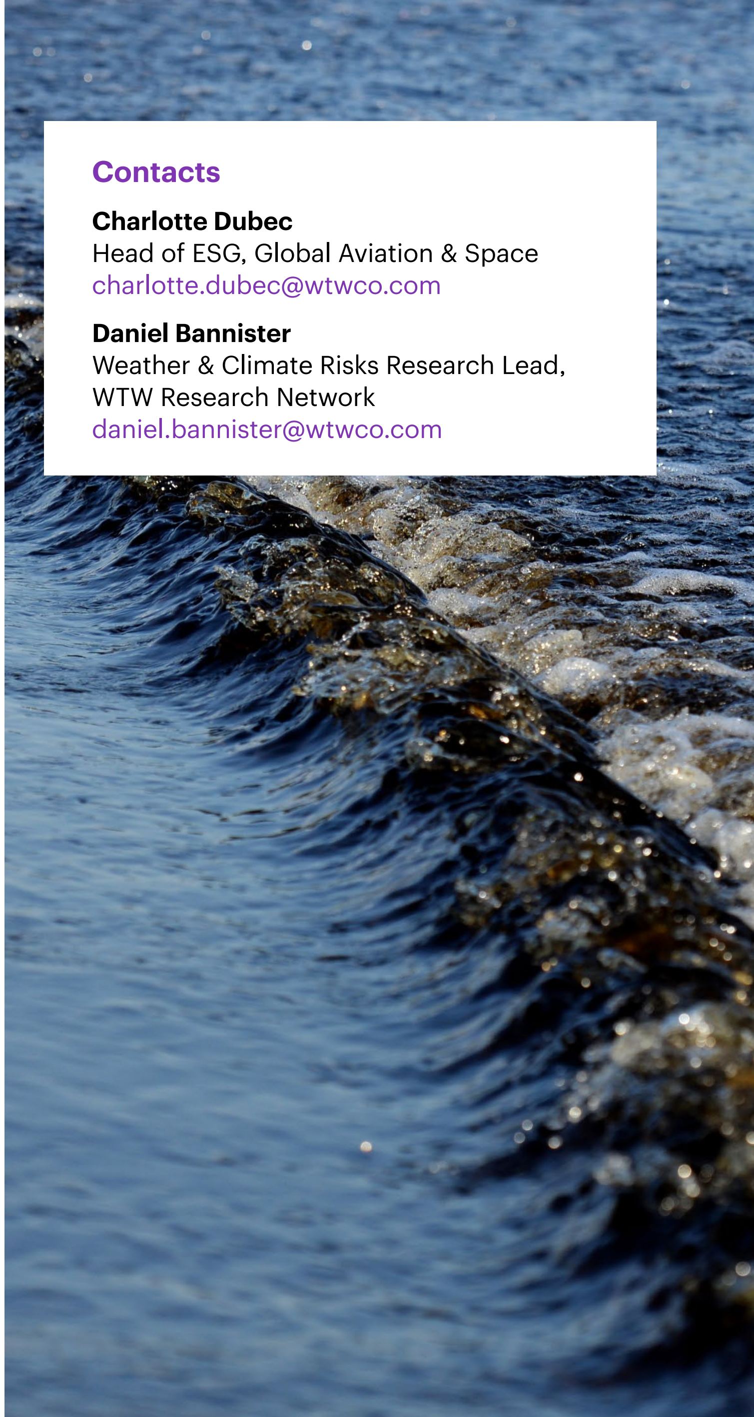
Use tools such as WTW's Airport Risk Index and Climate Diagnostic to analyze flood risks and extreme weather threats. Assess site-specific vulnerabilities and update risk management strategies to mitigate potential future disruptions.

Risk transfer solutions

Explore parametric insurance for non-physical damage business interruption. This provides rapid payouts based on predefined triggers, supporting recovery without physical damage.

Resilience planning

Invest in engineered solutions such as improved drainage, land use planning and enhanced forecasting systems. Partner with natural catastrophe risk specialists to align risk management strategies with evolving climate and urbanization patterns.



Contacts

Charlotte Dubec
Head of ESG, Global Aviation & Space
charlotte.dubec@wtwco.com

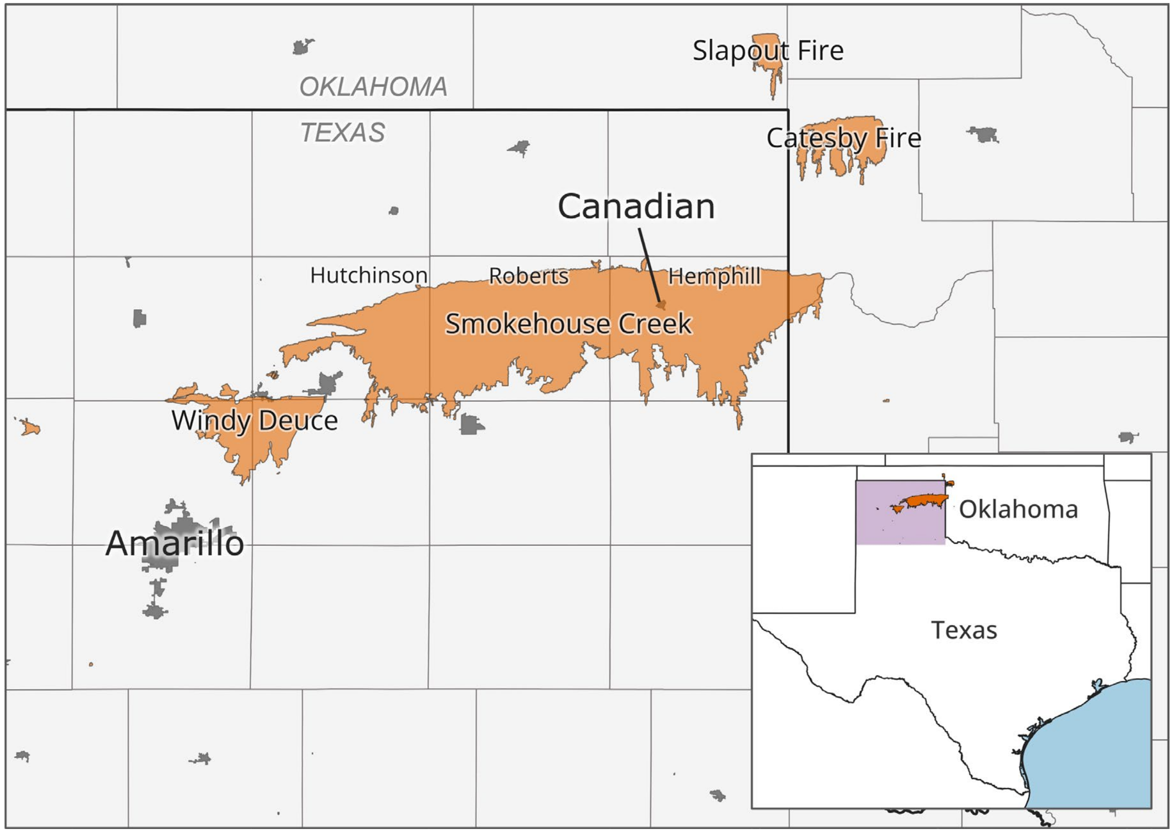
Daniel Bannister
Weather & Climate Risks Research Lead, WTW Research Network
daniel.bannister@wtwco.com

3.4 Five key insights from the 2024 Texas Panhandle wildfires

In February 2024, wildfires in the Texas Panhandle burned 510,000 hectares and destroyed over 500 structures. Ignited by downed power lines, they highlight risks from aging infrastructure, poor land management, declining population and climate change.

Unprecedented wildfires raged across the Texas Panhandle in late February 2024, consuming over 510,000 hectares and destroying over 500 structures. The Smokehouse Creek Fire, the largest wildfire on record in Texas and the second largest in the U.S., burned 426,600 hectares (Figure 1). Ignited on February 26, 2024, in Hutchinson County, this wildfire rapidly spread across Hemphill and Roberts counties, including the town of Canadian. It cut power to 11,000 people and claimed the lives of three people and 15,000 cattle. Insured losses are expected to exceed $350 million, while the Investigative Committee on the Panhandle Wildfires has estimated that total economic loss to the Panhandle, including the economies it feeds, may ultimately exceed $1 billion.[1]

Figure 1. **Extents of the largest fires in Texas and Oklahoma, between February and March 2024 (main panel, orange), with urban areas shown in gray. County borders shown in dark gray. Inset: The Panhandle region of Texas is highlighted with purple shading.**



Data source: National Interagency Fire Center, WFIGS 2024 Interagency Fire Perimeters.

[1] King, K. et al. Investigative Committee on the Panhandle Wildfires: A report to the House of Representatives 89th Texas Legislature. (2024).

The Smokehouse Creek Fire highlights how climate change, human factors and poor land management exacerbate wildfire severity, offering five key insights for risk managers.

1 Aging power infrastructure and regulatory gaps fuel fire risk

Investigations revealed that the Smokehouse Creek Fire was ignited by downed power lines from a broken utility pole, flagged for replacement two weeks earlier.[1] High winds on February 26, 2024,[2] caused the line to fall onto dry grass, igniting the fire. This incident reflects the trend over the past two decades, where power lines have been a leading cause of wildfires in the Texas Panhandle.[1]

The fire spread rapidly, fueled by grasslands created through the federal Conservation Reserve Program, which incentivized the conversion of cultivated fields. Additionally, regulatory gaps permitted oil and gas operators to neglect fuel loads and electrical safety issues at well sites, where exposed wiring and dilapidated equipment posed significant fire risks. At least one oil and gas operator has filed for bankruptcy protection amid pending litigation.[1]

This situation opens the door for potential subrogation claims by insurers against utility companies, like recoveries obtained from California utilities such as Pacific Gas and Electric following the 2017 and 2018 wildfires. Concerns about current utility regulations and their ability to address rising risks from extreme weather have also sparked discussions about adopting enhanced measures, similar to California's mandated proactive power shutoffs during high-risk conditions.[3]

2 Population decline hampers wildfire response

The Texas Panhandle's steady population decline due to cultural and economic shifts has made it harder for authorities to manage and respond to recent wildfires. According to the Texas Emergency Management Council,[4] fewer residents in the region means fewer volunteer firefighters and less local government tax revenue to support their volunteer fire departments (VFDs). The Panhandle is primarily supported by VFDs, and the sparse population in such a vast region limits the number of people available to spot the recent fires, many of which burned unnoticed for hours before being reported.

3 Texas faces an escalating threat from wildfires

Wildfire risk in Texas peaks during two specific periods: winter (February to April) and summer (August to October). Winter fires are fueled by cold fronts that bring dry air and high winds, while summer fires are often caused by high temperatures and prolonged droughts. Historically, the largest fires, including the Smokehouse Creek Fire in 2024, have occurred in winter.

Texas has seen a growing trend in wildfire magnitude and intensity, with fire seasons becoming longer and fires more destructive.[5] Climate change is expected to increase wildfire frequency and severity in the state due to higher temperatures and more frequent droughts. Research shows U.S. wildfire seasons are already becoming longer and more intense, with Texas experiencing fire weather over twice as often today compared with the early 1970s.[6]

Urbanization exacerbates this challenge, with over 85% of wildfires in Texas igniting within two miles of communities.[7] As more homes are built in the wildland-urban interface, prioritizing wildfire prevention and response is therefore crucial for both individuals and local authorities.

[2] National Weather Service. Two days of wind, dust and critical fire weather (26-27 February 2024). (2024).
[3] The Texas Tribune. Texas requires utilities to plan for emergencies. That didn't stop the Panhandle fires. (2024).
[4] Personal communication. (2024).
[5] Texas A&M Forest Service. Texas Fire Protection Plan. (2023).
[6] Climate Central. Burning Hot: 50 Years of Fire Weather Across the United States. (2024).
[7] Fire Information. Historical Fire Statistics. (2024).

4 Recent fires add to protection gap challenges

Texas homeowners' insurance premiums are significantly higher than the national average and have been rising due to increased weather-related claims and climate change concerns. Governor Greg Abbott noted that many homes in rural Panhandle counties affected by recent fires had no insurance.[8] Likewise, most fencing and cattle losses were uninsured unless landowners had special endorsements,[1] with preliminary estimates indicating $123 million in agriculture and related economic losses from the Smokehouse Creek Fire.

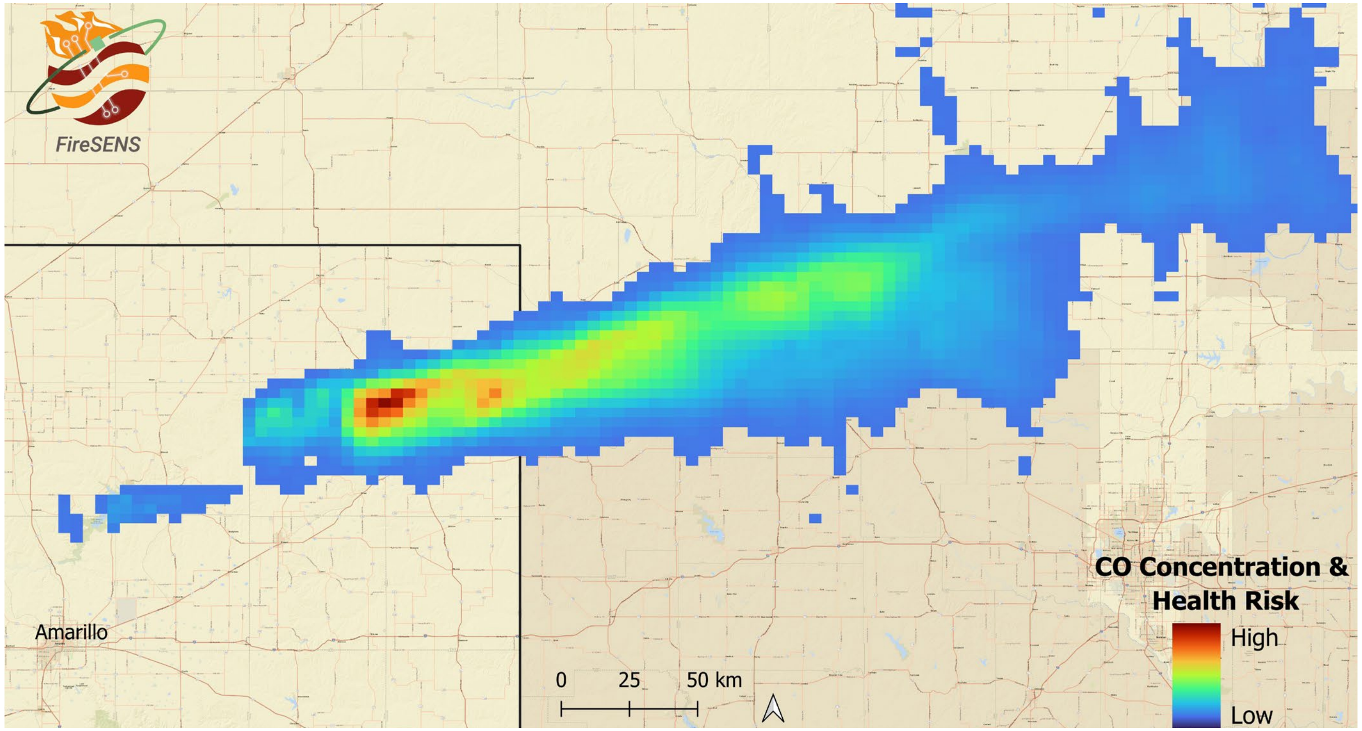
With climate change expected to increase the frequency and severity of extreme weather events in Texas, the risk to uninsured homeowners will grow. This highlights the urgent need to improve insurance affordability and close the protection gap, particularly for vulnerable rural and lower-income populations. The Investigative Committee on the Panhandle wildfires[1] recommended that the legislature evaluate ways to limit insurance premium increases for property and business owners affected by the fires and to make insurance coverage for fencing and cattle more widely available and affordable.

5 Monitoring hazardous aerosols will become increasingly important

Wildfire-induced air pollution has far-reaching impacts, as seen with Canada's 2023 wildfires, which affected over a third of the U.S. population. This degraded air quality has severe health consequences, contributing to approximately 340,000 premature deaths globally each year,[9] a number projected to double by 2050 in North America.[10]

Remote sensing technology, using thermal and aerosol data from satellites, provides near real-time information on wildfire progression and hazardous aerosols such as carbon monoxide. This helps emergency management and healthcare providers allocate resources effectively, mitigating the severe respiratory and cardiovascular impacts of wildfire smoke, as evidenced by the Texas Panhandle wildfire's high carbon monoxide concentrations (Figure 2).

Figure 2. **Carbon monoxide plume extent measured using the Sentinel-5P TROPOMI sensor on February 27, 2024. The areas indicated in red are experiencing the highest concentrations of CO and, consequently, the highest adverse health impacts.**



Data source: RSS-Hydro.

[8] The Texas Tribune. Many homes burned in the Texas wildfires weren't insured, creating a steep path to recovery. (2024).
[9] WWF. Fires, Forests and the Future: A Crisis Raging Out of Control? (2020).
[10] Ford, B. et al. Future fire impacts on smoke concentrations, visibility, and health in the contiguous United States. GeoHealth, 2(8), 229-247. (2018).

Implications for risk managers

Risk assessment

Evaluate wildfire exposure and vulnerability beyond the traditionally high-risk states on the U.S. West Coast. These assessments should consider how climate change is altering the frequency and severity of wildfire events.

Strategic preparedness and mitigation

Improve local mitigating actions, such as creating defensible space around structures. Insurers can support and incentivize these efforts through premium discounts and community programs.

Risk transfer solutions

Partner with natural catastrophe risk specialists to better quantify wildfire risks and develop innovative solutions for managing and transferring these risks, helping to close the protection gap.

Contacts

Daniel Bannister
Weather & Climate Risks Research Lead,
WTW Research Network
daniel.bannister@wtwco.com

Written by WTW Research Network Partners Chloe Campo, Alice Pais de Castro and Guy Schumann from RSS-Hydro, in collaboration with Daniel Bannister.

Source: City of Borger/ZUMA Press Wire

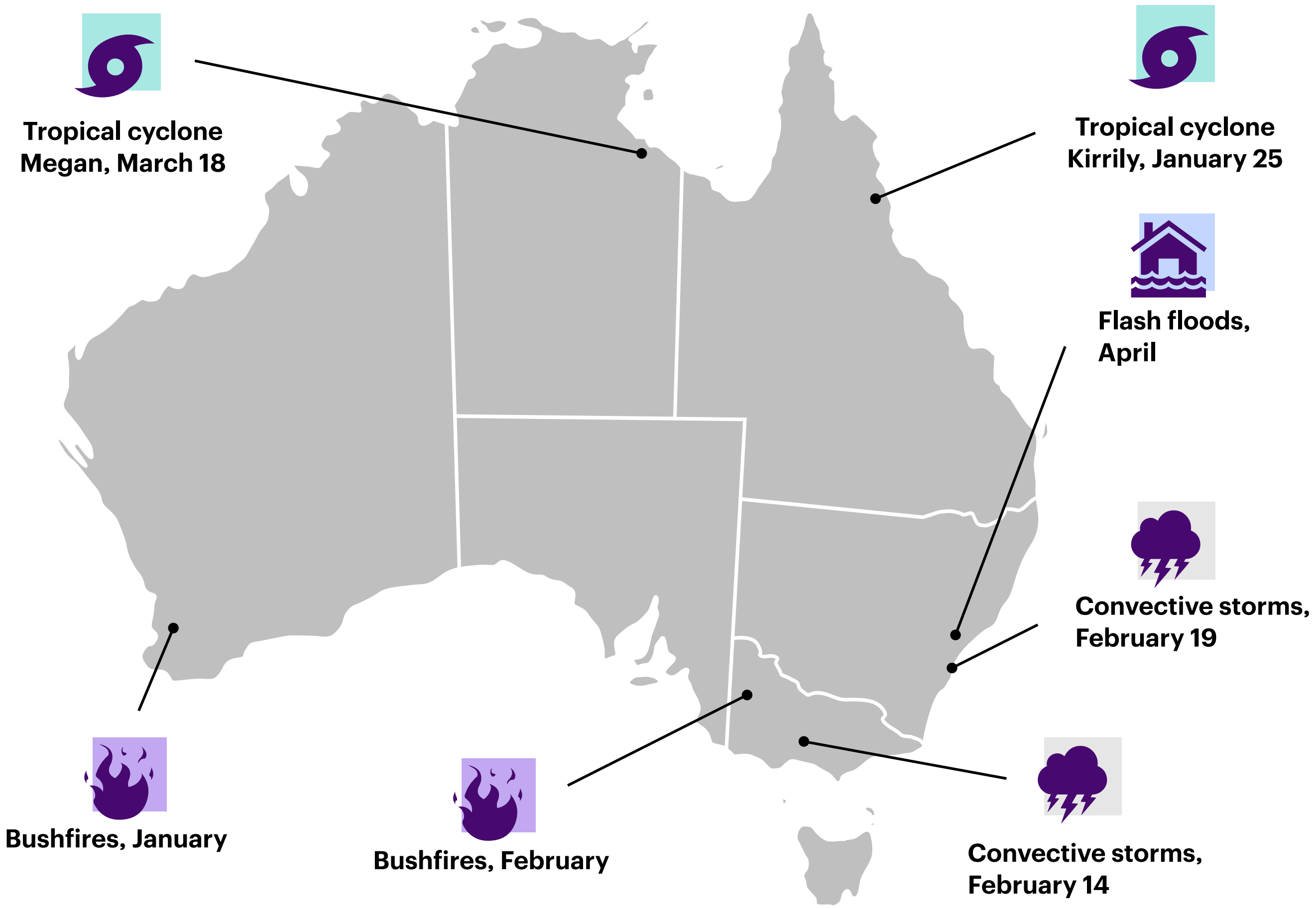
3.5 A storyline approach for navigating complex and compound climate risks in Australia

Climate change is set to increase the risk from natural catastrophes in countries such as Australia, complicating an already intricate business risk landscape. Storylines can help businesses better understand and manage these complex and often compound climate hazards.

Australia faced numerous natural catastrophe events in the first half of 2024 (Figure 1):

- **January 25:** Tropical Cyclone Kirrily, a Category 2 storm on the Australian Bureau of Meteorology (BoM) scale, struck Queensland, bringing strong winds and heavy rainfall.
- **February 14:** Valentine's Day convective storms caused Victoria's largest blackout on record, affecting 530,000 homes and businesses, resulting in over AU $100 million (US $67 million) in insured losses.
- **February 19:** Convective storms hit New South Wales, causing injuries, transport disruptions and flash flooding in Sydney.
- **March 18:** Tropical Cyclone Megan made landfall as a Category 3 storm (BoM scale) in the Northern Territory, bringing strong winds, heavy rainfall and flooding.

Figure 1. **Notable natural catastrophe events in Australia in the first half of 2024.**



- **Early April:** Widespread flash flooding in New South Wales led to AU $176 million (US $117 million) in insured losses.
- **Throughout early 2024:** Bushfires affected both Perth and Victoria, leading to the evacuation of tens of thousands of people.

While these events did not result in significant economic damage, they have highlighted the natural catastrophe risks that Australia faces, which are expected to escalate with climate change. The Intergovernmental Panel on Climate Change (IPCC) projects that climate change will increase the frequency and/or intensity of extreme weather events in Australia, such as bushfires, floods and tropical cyclones, leading to heavier rainfall, stronger winds and longer wildfire seasons (Table 1). For example, events such as the flash flooding in April — historically mostly confined to coastal regions — are becoming more common farther inland as global warming is influencing the climate drivers that determine the frequency and location of extreme precipitation.[1]

Table 1. **Projected climate change impacts to major atmospheric perils in Australia according to the IPCC.[2]**

Peril	Direction of change	Projected impacts
Bushfires	↑ Bushfires	Bushfires in Australia are projected to increase in frequency, severity and duration, particularly in southern and eastern Australia. This is primarily due to increasing mean temperature and cool season rainfall decline.
Tropical cyclones	↓ Number of tropical cyclones ↑ Proportion of severe convective storms	Fewer tropical cyclones are expected, but a greater proportion of them will be severe.
Severe convective storms	? Changes uncertain	Future projections for lightning, hail, tornadoes and extreme wind gusts are uncertain. Long-term high-quality observations are lacking, and climate models are unable to simulate these small-scale phenomena.
Flooding	↑ Flash flooding ↑ River flooding	More intense extreme rainfall events are expected, leading to increased flash flooding, especially in northern Australia. Smaller increases may occur in southern Australia, where drier antecedent conditions may lead to less surface runoff. Rainfall totals from east coast lows and tropical systems are expected to increase, leading to increased flood risk in the larger river catchments.

[1] Speer, M., Leslie, L., Hartigan, J. & MacNamara, S. Changes in frequency and location of East Coast low pressure systems affecting Southeast Australia. *Climate* 9(3), 44 (2021).
[2] IPCC. Climate Change 2021: The Physical Science Basis. (2021).

Storylines for climate risk management

Natural catastrophes such as these can disrupt critical infrastructure and business value chains in a variety of complex and interconnected ways. Using "storylines" — physically consistent narratives of plausible future events — helps us understand and manage these complex risks in a warming world. For instance, a storyline could depict a future where prolonged droughts lead to severe water shortages, increasing business costs and downtime — underscoring the need for effective water management strategies. These narratives are oriented around events that people can easily understand and relate to and allow us to clearly communicate which aspects we are more or less confident in (known as "partitioning uncertainty").

WTW works closely with companies in the region to translate the latest climate and impact science into information that can be used to make business decisions. This includes the use of storylines that integrate climate model outputs, observational data and expert judgment to create extreme but plausible scenarios. These can guide new or upgraded risk management controls — usually in the context of a wider Enterprise Risk Management (ERM) framework.

A storyline approach is particularly useful for two types of risks:

- Complex business risks with large uncertainties
- Compound physical climate risks

Complex business risks with large uncertainties

Consider road freight worker health and safety, an important issue for many companies. In Australia, strong winds and bushfires have contributed to serious incidents in the past.[3,4] A company might want to understand future climate impacts on worker or contractor safety to improve controls or business continuity plans. Conventional climate models — even locally downscaled — cannot provide these answers directly, but storylines, based on diverse information sources, can.

Key information sources for assessing bushfire risks in this context include:

- **Precedent events:** Analyzing past incidents from Australia and other regions (e.g., fires in Maui, Hawaii, in 2023[5] or Chile in 2024) to understand their causes and impacts. What happened there and could it happen here?
- **Vulnerability and exposure:** Examining how many vehicles use specific roads and at what times. Are certain types of vehicles more susceptible to risks?
- **Current and future hazard:** Reviewing historical data on where fires have occurred in Australia and projecting how bushfire hazards may change over time in terms of severity, frequency and distribution. How might these changes affect road freight operations in the future?

An expert panel can then deliberate on this information in a structured manner.[6] Scores can be considered around the *likelihood* of a scenario occurring (noting that a *likelihood* score is not always needed in a storylines approach). Importantly, a *confidence* score can be given, which reflects the experts' level of agreement, together with the amount and quality of the available evidence.[7]

[3] The Sydney Morning Herald. Three men died in WA bushfire. (2007).
[4] The West Australian. Wind gust causes bus crash. (2009).
[5] WTW. Natural Catastrophe Review July – December 2023. (2023).
[6] Hemming, V., et al. A practical guide to structured expert elicitation using the IDEA protocol. Methods Ecol Evol.; 9: 169–180. (2018).
[7] Mastrandrea, M.D., et al. Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties. Intergovernmental Panel on Climate Change (IPCC). (2010).

Compound physical climate risks

Traditional risk assessments track individual threats by identifying historical trends in the magnitude and frequency of single hazards; however, this approach does not capture the risk from interconnected and cascading hazards, which have the potential to amplify risks for a company's value chain. The resulting compound risks differ significantly from independent risks, often with distinct likelihoods and impacts.[8,9]

The floods, tropical cyclones, convective storms and bushfires experienced in Australia during the first half of 2024 exemplify how hazards can strike in quick succession, creating transport delays, power cuts and critical supply shortages as well as affecting worker availability and safety.

A storyline approach views risks through the lens of the entire value chain, identifying interactions and compounding effects, which add up to something greater. Analyzing factors that could produce a significant shock event can inform shorter-term business continuity plans and longer-term strategic decisions such as mergers and acquisitions.

In the face of global change, there has never been a more important time to consider complex and compounding risks and their impact on a company's short-term performance and long-term prosperity.

Implications for risk managers

Storylines for climate risk management

Employ storylines to understand and manage complex and compound climate risks. Integrate climate model outputs, observational data and expert judgment to create plausible scenarios, guiding the development of new or upgraded risk management controls.

View risks across value chains

Analyze how interconnected and cascading hazards can impact the entire value chain. Storylines can help identify vulnerabilities and inform business continuity plans and strategic decisions, ensuring robust preparation for climate-induced disruptions.

Risk transfer

Partner with natural catastrophe risk specialists to better quantify wildfire risks and develop innovative solutions for managing and transferring these risks, helping to close the protection gap.

Contacts

Ben Rabb
Associate Director, Climate Practice
benjamin.rabb@wtwco.com

Anna Haworth
Associate Director, Climate Practice
anna.haworth@wtwco.com

Jessica Boyd
Modelling Research and Innovation Lead, WTW Research Network
jessica.boyd@wtwco.com

[8] Network for Greening the Financial System. Compound Risks: Implications for Physical Climate Scenario Analysis. (2023).
[9] Arribas, A., et al. Climate risk assessment needs urgent improvement. Nat Commun 13, 4326. (2022).

3.6 El Niño and climate change fuel Brazil floods

Catastrophic flooding in Brazil in April and May was a stark reminder of the compound effect of El Niño and climate change. The unprecedented rainfall — now twice as likely due to global warming — led to devastating flooding across the state of Rio Grande do Sul.

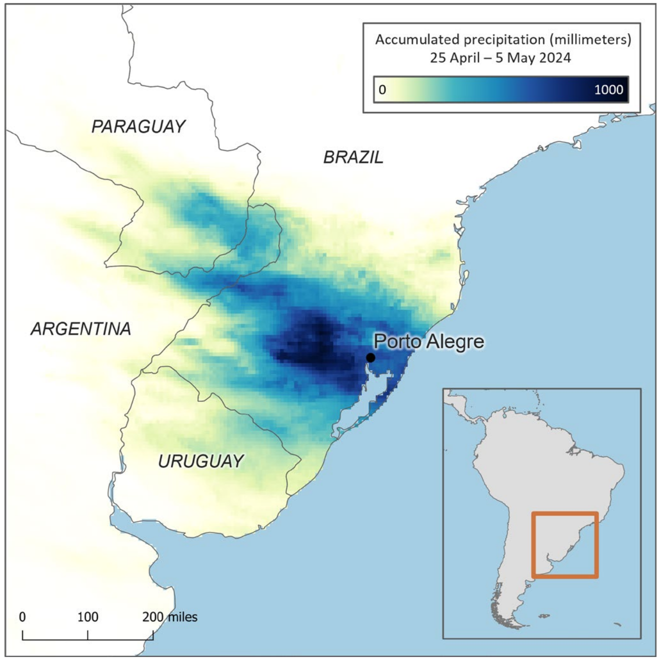
Record-breaking rainfall in the Rio Grande do Sul (RGDS) province of Brazil — equivalent to three normal months of rainfall in a two-week period — caused flooding over an area the size of the U.K. (Figure 1). Two-week rainfall accumulations reached almost 1,000 millimeters in some parts of RGDS, and the state's capital, Porto Alegre, registered 327 millimeters of rainfall in less than a week at the end of April (Figure 2). The flooding has also been long-lasting, persisting for almost all of May with flood depths reaching 5 meters in some locations.[1] Economic losses are expected to exceed 22 billion Brazilian Reais (US $4 billion).

More than 580,000 residents were displaced,[2] over one-third of RGDS's population lost access to running water,[3] hundreds of thousands were without power for weeks, and 170 fatalities were reported. The flooding also disrupted health services and infrastructure, and outbreaks of waterborne diseases, particularly leptospirosis, compounded the challenges faced by health authorities and emergency responders in the region.

RGDS, a key producer of rice, soy and livestock, is vital to the country's economy. Although some crops were harvested before the floods, storage facilities were likely damaged; many livestock were lost, and remaining animals face feed shortages.[4]

The regional airport in Porto Alegre was closed for several days, and local transport networks have been disrupted by flooding and landslides. Additionally, the floods disrupted supply chains throughout the region. For example, major auto manufacturers such as Chevrolet and Volkswagen have reported production slowdowns or stoppages.

Figure 1. **Precipitation accumulation in millimeters between April 25 and May 5 2024.**



Data source: NASA-GPM.

[1] NASA. Southern Brazil Submerged. (2024).
[2] United Nations Office for the Coordination of Humanitarian Affairs. Brazil: Floods and landslides, update. (2024).
[3] World Weather Attribution. Climate change, El Niño and infrastructure failures behind massive floods in southern Brazil. (2024).
[4] United States Department of Agriculture Foreign Agricultural Service. Brazil: Unprecedented floods in Rio Grande do Sul threaten Brazil's agricultural output. (2024).

Figure 2. **Flooding in Porto Alegre on May 7, 2024.**

Source: Carlos Macedo/dpa/Alamy Live News

Compound impact of El Niño and climate change

Both the phase of the El Niño-Southern Oscillation (ENSO) and climate change are thought to have contributed to the severity of the recent flooding. The El Niño phenomenon, characterized by warmer-than-average sea surface temperatures in the central and eastern tropical Pacific Ocean, facilitates the transport of warm, moist air toward southern Brazil. This increased moisture supply can increase the intensity and duration of rainfall events, which leads to an elevated risk of flooding.[5] Compared with a neutral ENSO phase, the recent El Niño phase is estimated to have increased the likelihood of this extreme rainfall event by two to five times and its intensity by 3% to 10%.[6]

El Niño alone isn't to blame for the severity of the recent flooding. Scientists have found that human-induced climate change doubled the likelihood of this event and increased the intensity by 6% to 9%,[6] aligning with more general future projections of increases in both flash flooding and river flooding. This trend is already evident in southeastern Brazil, where annual precipitation and high-intensity events are increasing.[8]

Deforestation, urbanization and aging infrastructure

Alongside climate change and El Niño, social factors also played a role in exacerbating the disaster's impacts. Deforestation, urbanization encroaching on flood-prone land and inadequate maintenance of flood protection infrastructure in cities such as Porto Alegre may have amplified the impact of the floods. Forecasts and warnings of the floods were available nearly a week in advance, but the warnings may not have reached all of those at risk, and the public may not have understood the severity of the potential impacts or how to respond appropriately.

While improved risk assessments, warnings and flood defenses may save lives and reduce damage, the low insurance penetration rates — around 30% for homes in southern Brazil[9] — mean that many uninsured residents may not be able to afford to rebuild after the recent flooding. Against the backdrop of increasing flood risk under climate change, some local people say they have no desire to return to homes they believe are unsafe, prompting discussions by officials about the once-inconceivable relocation of entire communities to higher ground.

[5] Cai, W et al. Climate impacts of the El Niño–Southern Oscillation on South America. Nat Rev Earth Environ 1, 215–231. (2020).
[6] World Weather Attribution. Climate change, El Niño and infrastructure failures behind massive floods in southern Brazil. (2024).
[7] IPCC. Sixth Assessment Report. (2023).
[8] Marengo, J.A., et al. Heavy rainfall associated with floods in southeastern Brazil in November–December 2021. Natural Hazards *116*, 3617–3644. (2023).
[9] Fitch Ratings. Heavy rains expected to have limited impact on Brazilian insurers. (2024).

Implications for risk managers

Risk assessment and early warning

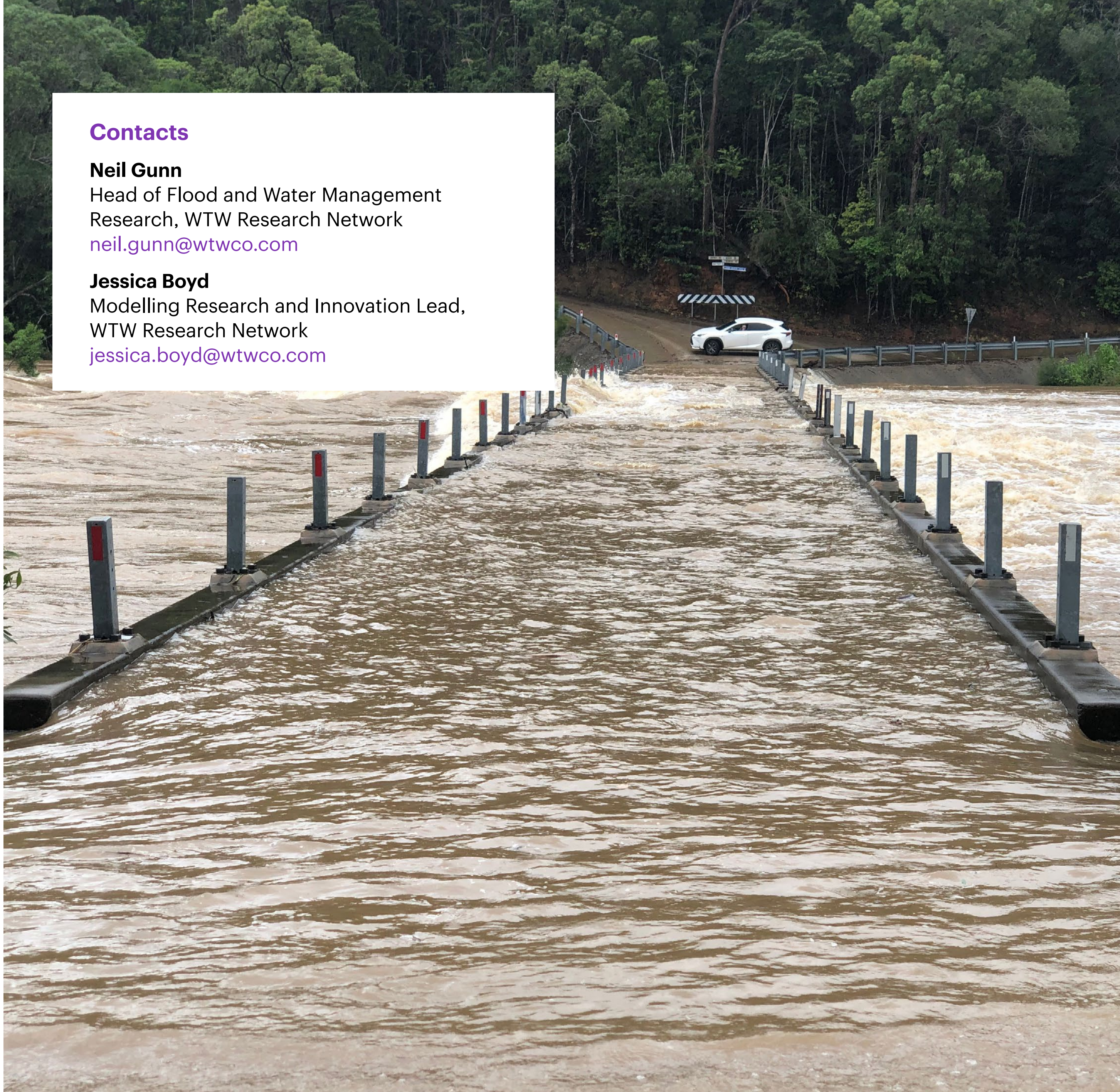
Conduct comprehensive flood risk assessments that consider the impacts of climate change, deforestation and urbanization. Focus on high-risk areas, such as urban settlements with poor drainage. Improve communication strategies to ensure the public understands potential impacts and knows how to respond.

Infrastructure risks

Identify, quantify and mitigate systemic risks, including potential failures of flood defenses and key infrastructure, especially in densely populated areas such as Porto Alegre.

Risk management and transfer

Collaborate with natural catastrophe risk specialists to manage flood risks through innovative risk transfer solutions, promote higher insurance penetration and quantify climate change impacts on flood risks.



Contacts

Neil Gunn
Head of Flood and Water Management Research, WTW Research Network
neil.gunn@wtwco.com

Jessica Boyd
Modelling Research and Innovation Lead, WTW Research Network
jessica.boyd@wtwco.com

3.7 Prolonged Mediterranean drought affects agriculture production and prices

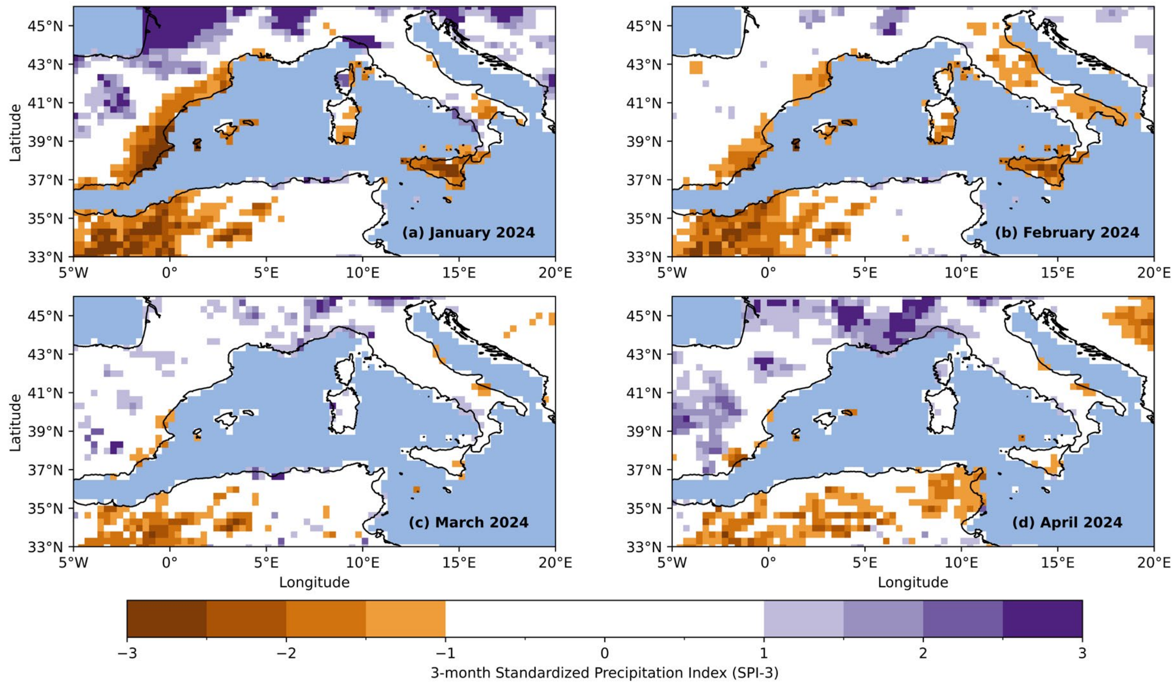
A severe drought in the Mediterranean has significantly impacted olive production. This event shines the spotlight on the vulnerability of food supply chains to droughts, which are predicted to become more prevalent under climate change.

The Mediterranean region is currently experiencing a severe drought, driven by a complex interplay of meteorological and hydrological factors. **Northern Africa** has been enduring these conditions for over six years, and southern **Italy**, **Spain** and **Portugal** for approximately two years. In **Cataluña**, in the northeast of Spain, the drought has persisted for more than 1,000 consecutive days.

Precipitation shortfalls

The Mediterranean climate is characterized by hot, dry summers and mild, wet winters; however, since 2021, winter rainfall has significantly decreased, especially in the Iberian Peninsula and the Maghreb in **Northern Africa**. The Standardized Precipitation Index (SPI) has consistently shown negative anomalies across southeastern Spain and northern Africa, indicating a substantial lack of rainfall (Figure 1a).

Figure 1. **Three-month Standardized Precipitation Index (SPI-3) for the three months up to and including (a) January 1, 2024, (b) February 1, 2024, (c) March 1, 2024, and (d) April 1, 2024. An index of less than –1 indicates drier than normal conditions; an index from –1 to 1 indicates near normal conditions, and an index above 1 indicates wetter than normal conditions.**



Data source: European Commission, Joint Research Centre (JRC).

[1] Catalan Water Agency. The drought viewer. (2024).
[2] Toreti, A., et al. Drought in the Mediterranean Region — January 2024, Publications Office of the European Union, Luxembourg, JRC137036. (2024).

By March 2024, reservoirs in **Cataluña** were at just 15% of their capacity, though some relief came with late April and early May 2024 rainfall, raising levels to nearly 30% capacity (Figure 1d).[1]

Snow cover in the **Alps** and **Apennines** has also been well below average. Snow cover in **Italy**, for example, has decreased by 63% compared with the 2011 – 2022 average,[2] resulting in reduced snowmelt and low river and reservoir levels.

Furthermore, in 2023 and early 2024, Mediterranean temperatures were often more than 2°C above average, exacerbating the drought and increasing water demand.[2]

Agricultural impacts and economic losses

The effects of drought impact everything from municipal water supplies to the integrity of infrastructure. A significant consequence is the availability of water for agriculture. Spain, one of the largest European producers and exporters of fruit and vegetables, has been particularly hard-hit.

The olive, a cornerstone of Mediterranean culture and cuisine, exemplifies the drought's severity. To meet growing demand, global olive production has tripled since the early 1960s. Spain leads the olive market, contributing 45% to the annual US $15 billion global market; other major producers such as Italy and Greece each contribute around 10%.[3]

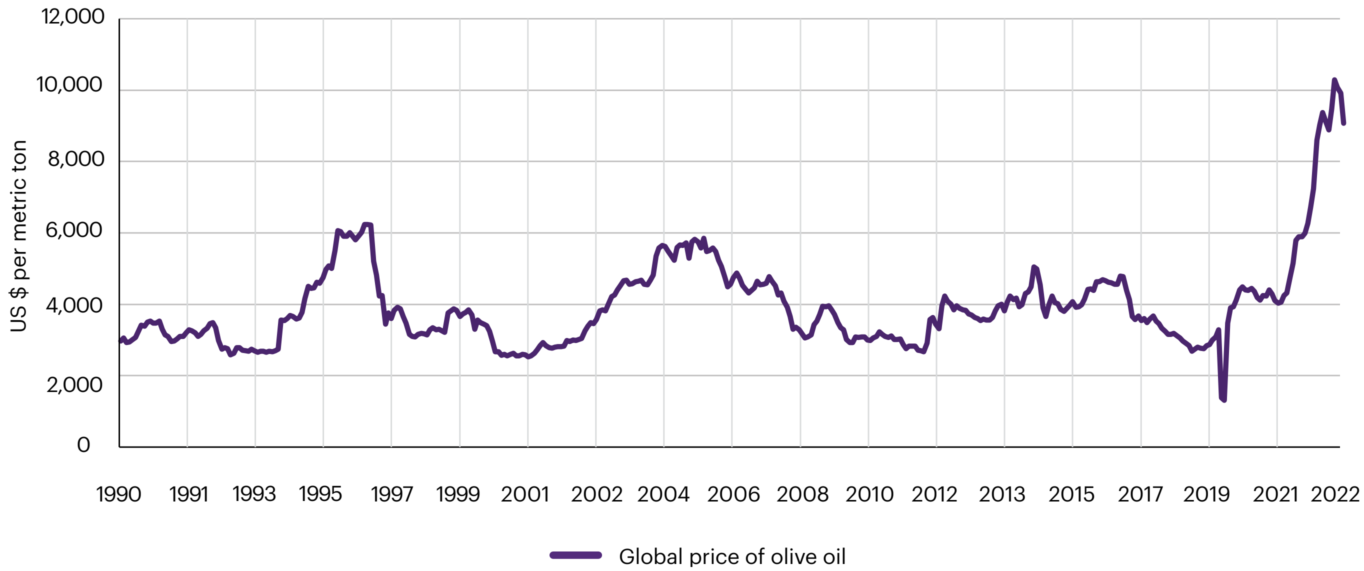
However, warmer winters coupled with a prolonged drought have significantly reduced olive yields. In Spain, production fell to half of its usual volume in 2022 – 2023.

The loss in olive production for Italian and Spanish growers during the 2022 – 2023 season was estimated at €4.15 billion (US $4.45 billion),[4] leading to a surge in olive oil prices (Figure 2). Retail prices for olive oil rose more than 2.5 times, making it one of the most shoplifted items in Spain.

Recently, the situation has begun to improve, with production nearing the five-year average, indicating that prices are expected to start normalizing.

While this story highlights losses to olive growers, many other Spanish farmers have suffered drought-related losses as well. With around 40% of Europe's fruit production concentrated in Spain,[5] concerns about global food security are mounting as the climate warms.

Figure 2. **Global price of olive oil since January 1990 to present. Prices are period averages in nominal U.S. dollars.**



Data source: FRED Economic Data.

[3] International Olive Council. The world of olive oil. (2022).
[4] International Olive Oil. Changes in production of olive oil yield figures.
[5] Eurostat. Where do we grow our fruit and vegetables? (2019).
[6] Olive Oil Times. Spanish Lawmakers Approve €2B Aid for Agriculture Sector Hit by Drought. (2023).
[7] WeAreWater Foundation. Olive Trees: Beyond the Climate Crises. (2023).

Government response and challenges

The Spanish government has responded by approving €2.2 billion (US $2.36 billion) in aid for the agricultural sector, including €40.5 million (US $43.5 million) in insurance subsidies; however, most of Spain's olive farmers will not benefit, as only 4.5% of the country's olive grove area is insured.[6]

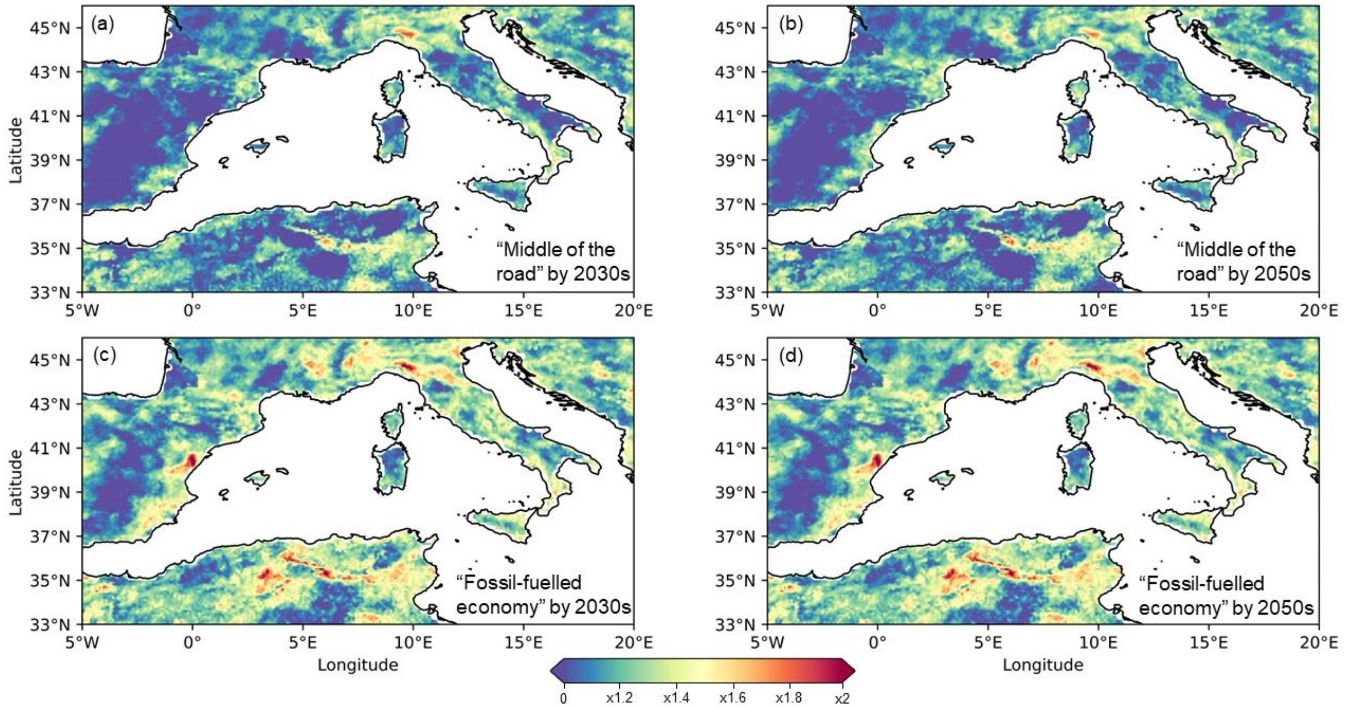
Around 80% of Spain's olive groves are rain-fed and highly vulnerable to changes in precipitation, with the remainder utilizing irrigation systems. Increasing irrigation might boost olive production, but in recent decades this has caused environmental issues. In areas such as La Loma, Spain, the over-extraction of groundwater for irrigation has depleted aquifers, leading to long-term unsustainability.[7]

Climate change and future drought risk

Climate change is expected to exacerbate drought conditions in the Mediterranean by causing higher temperatures and shifting precipitation patterns. These changes will lead to faster soil moisture depletion and reduced water retention, impacting water availability for agriculture and other uses.

WTW's Global Climate Hazard Indices indicate that areas already under water stress, such as mid and northern **Cataluña**, are likely to experience more frequent droughts (up to 1.5 times) in the next decade even under a "middle of the road" climate scenario (Figure 3a). Conditions could worsen further if we fail to transition to a lower carbon economy and instead follow a high emissions trajectory. For instance, drought frequency could significantly increase in the coming decades, not just to northern **Cataluña** but also to most of the Spanish Mediterranean coast under a fossil-fueled economy (Figures 3c and 3d).

Figure 3. **Anomaly of annual probability of drought occurrence for (a) SSP2-4.5 2030s, (b) SSP2-4.5 2050s, (c) SSP5-8.5 2030s, (d) SSP5-8.5 2050s. Drought conditions are defined by the 12-month Standardized Precipitation and Evaporation Index (SPEI). Drought occurrences are determined by events when SPEI drops below –1 (moderate drought or worse). In this figure, a climate anomaly is defined as the difference between a future scenario in comparison with the current climatic conditions, where each time horizon comprises 30 years of daily data.**



Source: WTW's global climate hazard indices.

Other Mediterranean regions such as **southern France**, **Italy** and **northern Africa** may also see more damaging drought conditions, with drought frequency increasing on average 1.4 to 1.6 times in most areas by the next decade. Addressing drought risks and opportunities

Addressing drought risks and opportunities

WTW is working with companies across the agriculture, food and beverage sector to identify, quantify and manage risks and opportunities from a variable and changing climate. Companies can benefit from risk screening their portfolio of assets, operations and supply chain to identify exposure now and under different future climate scenarios. This may lead to deeper dive analyses of the most at-risk sites, to inform decisions about how best to avoid, reduce and transfer risk. This type of work assists with risk management directly and informs disclosure and reporting on climate-related risks and opportunities, including the Corporate Sustainability Reporting Directive, International Financial Reporting Standards and the Securities and Exchange Commission climate rule.

Implications for risk managers

Risk screening and analysis

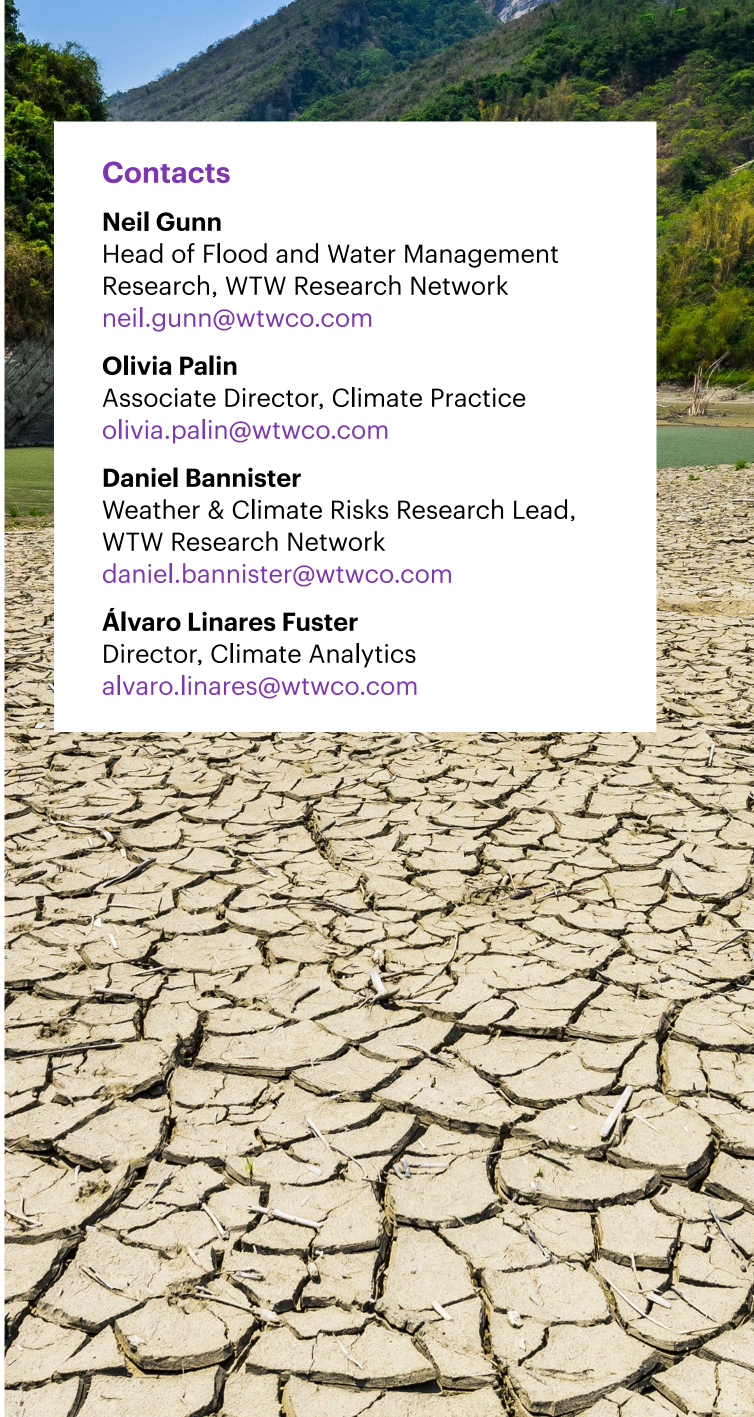
Conduct screenings of portfolios, operations and supply chains to identify drought exposure concentrations. Perform in-depth analyses of high-risk sites to develop effective risk mitigation strategies. Check current insurance policies for direct and indirect drought coverage.

Climate-related reporting and compliance

Use drought risk assessments to improve climate-related disclosures and ensure compliance with reporting standards.

Risk management and transfer

Partner with natural catastrophe risk specialists to develop innovative solutions for managing and transferring drought risks, adopting new technologies and enhancing resilience.



Contacts

Neil Gunn
Head of Flood and Water Management Research, WTW Research Network
neil.gunn@wtwco.com

Olivia Palin
Associate Director, Climate Practice
olivia.palin@wtwco.com

Daniel Bannister
Weather & Climate Risks Research Lead, WTW Research Network
daniel.bannister@wtwco.com

Álvaro Linares Fuster
Director, Climate Analytics
alvaro.linares@wtwco.com

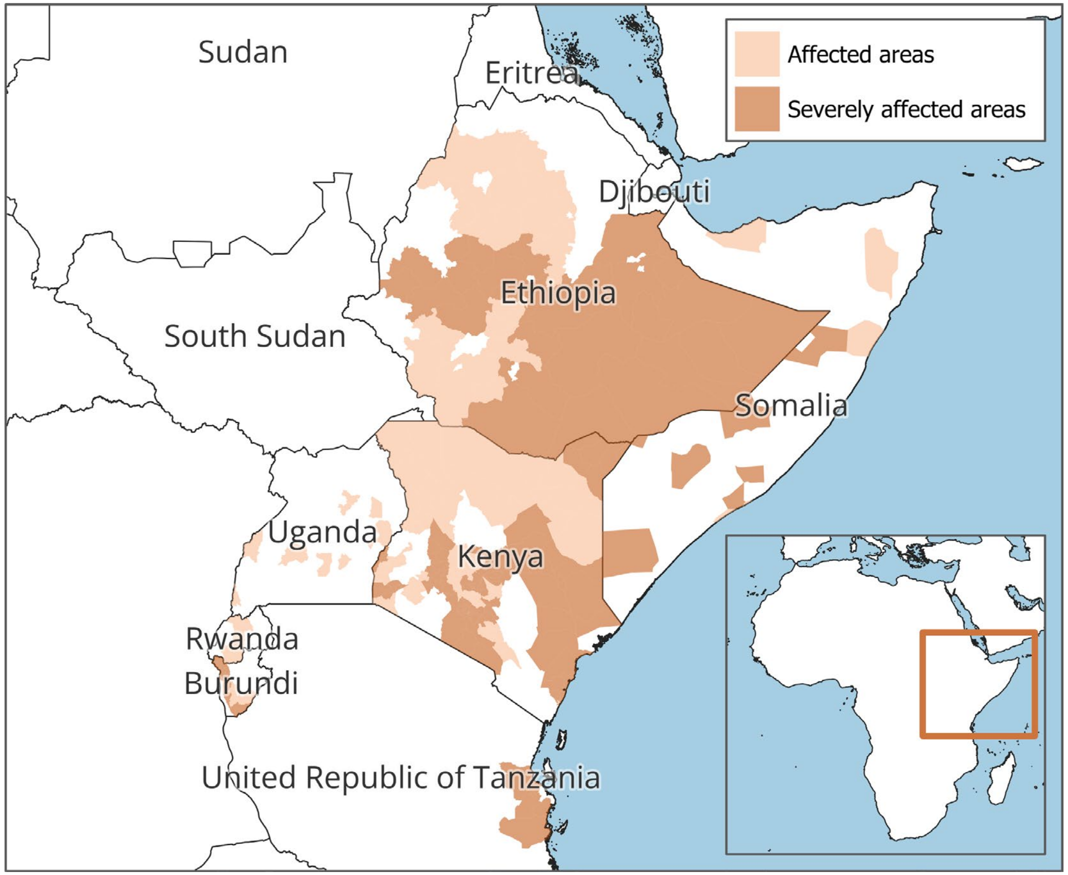
3.8 Drought and rains bring severe flooding to East Africa

From March to May 2024, heavy rains over East Africa caused severe flooding that affected more than 1.6 million people. Effective risk management requires robust assessments and disaster financing, such as parametric insurance, to enable rapid response and recovery.

From late March to May 2024, East Africa experienced severe flooding due to exceptionally heavy rainfall during the “long rains” season. Nearly 1.6 million people were affected across multiple countries, including Kenya, Tanzania, Burundi, Somalia and Ethiopia (Figure 1). Tens of thousands of homes were impacted, with over 480,000 people displaced and 528 fatalities reported. In addition, the flooding caused significant damage to infrastructure and agriculture.

This event marks the second instance of severe flooding in six months, following heavy rainfall during the "short rains" season (October to December) in 2023. From 2020 to 2023, East Africa experienced a drought that caused food insecurity, particularly in the Horn of Africa. The prolonged drought hardened the soil, reducing infiltration and increasing runoff, which worsened the 2023 flooding.

Figure 1. **Areas (local administrative boundaries) affected by the flooding in East Africa between May 3 and May 30, 2024.**



Data source: United Nations Office for the Coordination of Humanitarian Affairs.[1]

[1] United Nations Office for the Coordination of Humanitarian Affairs. Eastern Africa heavy rains and flooding: Flash update 4. (2024).

Why have the rains been so intense?

The rainy seasons in East Africa are primarily influenced by the seasonal movement of the Intertropical Convergence Zone, a belt of low pressure that moves north and south of the equator and brings rain as it passes over the region.

Seasonal rains are also affected by major climate patterns, namely the Indian Ocean Dipole (IOD) and El Niño-Southern Oscillation. When sea surface temperatures are warmer in the western Indian Ocean, the IOD is in a positive state, which can boost East African rainfall. When this occurs simultaneously with an El Niño, as it did in early 2024, rainfall can become much heavier, with annual accumulations exceeding 200% of the average.[2]

Another consequence of these meteorological conditions was the formation of two rare tropical cyclones in May, which brought heavy rainfall to East Africa's coastal regions, causing additional flooding. Tropical Cyclone Hidaya made landfall on Tanzania's Mafia Islands Archipelago, while Tropical Cyclone Ialy, despite staying offshore, impacted Kenya's coastal areas.

Consequences for people, infrastructure and agriculture

Some of the worst flooding occurred in urban areas. For example, in Nairobi, Kenya, weather stations recorded between 500 and 798 millimeters of rain in April, compared with an average of 150 millimeters. On April 28, almost 120 millimeters fell in 24 hours, causing severe flooding, especially in informal settlements.[3] Since 1986, Nairobi's population has more than doubled, with over 60% of the residents living in just 6% of the city's area in tightly packed informal settlements. Despite recent improvements, these areas have a high ratio of impermeable surfaces and poor drainage and are particularly vulnerable to flooding.

The impacts in cities such as Nairobi highlight the need for proactive risk management to protect citizens from flooding and other climate-related impacts. Many urban areas are already taking action to boost their resilience to such events, as detailed in a recent report by C40 Cities and WTW.[4]

The recent flooding also damaged major highways, roads and bridges across multiple countries, hampering transportation and access to affected areas. Additionally, electricity infrastructure and water treatment plants were affected, leaving some communities without access to power and clean water.

Cities were not the only areas impacted by flooding. In late April blocked pipes trapped water behind an embankment, which gave way in Mai Mahiu, a town in Kenya's rift valley. The resulting wave swept through several villages at night, leading to over 60 deaths — many of which were caused by landslides as well as flooding. This highlights the need for infrastructure maintenance, especially under the strain of extreme weather events.

Thousands of hectares of cropland were also submerged or destroyed by the floods, damaging irrigation systems, pumps and pipes and affecting food security and horticultural exports, which are vital to the local economy.

Building financial resilience to severe flooding events

The extreme rainfall in East Africa and the associated flooding, secondary perils (e.g., landslides) and cascading impacts (e.g., embankment collapses) exemplify the need for quantitative risk assessments, which may form the basis for comprehensive disaster risk management strategies. Such strategies can address all phases of the risk management cycle, which includes preparedness, response, recovery and reconstruction. To ensure timely implementation, these strategies must be accompanied by robust disaster risk financing (DRF) approaches.

[2] Urban Africa Risk Knowledge, University of Cape Town. Nairobi climate profile: Full technical version. (2017).
[3] Misiani, Z., et al. Nairobi floods 2024 during 'long' rain season. International Center for Humanitarian Affairs — Kenya Red Cross Society, Nairobi, Kenya. (2024).
[4] C40 Knowledge Hub. Loss and damage: Challenges and opportunities for city leadership. (2024).

One form of DRF gaining traction is parametric insurance.[5] Unlike traditional indemnity insurance, parametric insurance pays out based on a pre-agreed trigger threshold (e.g., amount of rainfall over a 24-hour period, measured at a specified rain gauge). This strategy bypasses the need for a lengthy loss adjustment process, which allows funds to be quickly released to the policy holder. In the case of a city, these funds could be used to finance emergency response activities such as clearing debris, restoring critical infrastructure and supporting displaced people. For example, such an approach has been developed for the city of Medellin, Colombia, to finance emergency response actions following earthquakes, rainfall-related flooding and landslide events.[6]

At the sovereign scale, the African Union's African Risk Capacity provides parametric insurance policies for drought, flood and tropical cyclone hazards.[7] Such multi-country risk pooling arrangements (which also exist in the Pacific, the Caribbean and Southeast Asia) help to build insurance capacity and can achieve more affordable and stable insurance pricing, which is important to encourage enduring resilience to climate-related risks.

Implications for risk managers

Comprehensive risk assessment

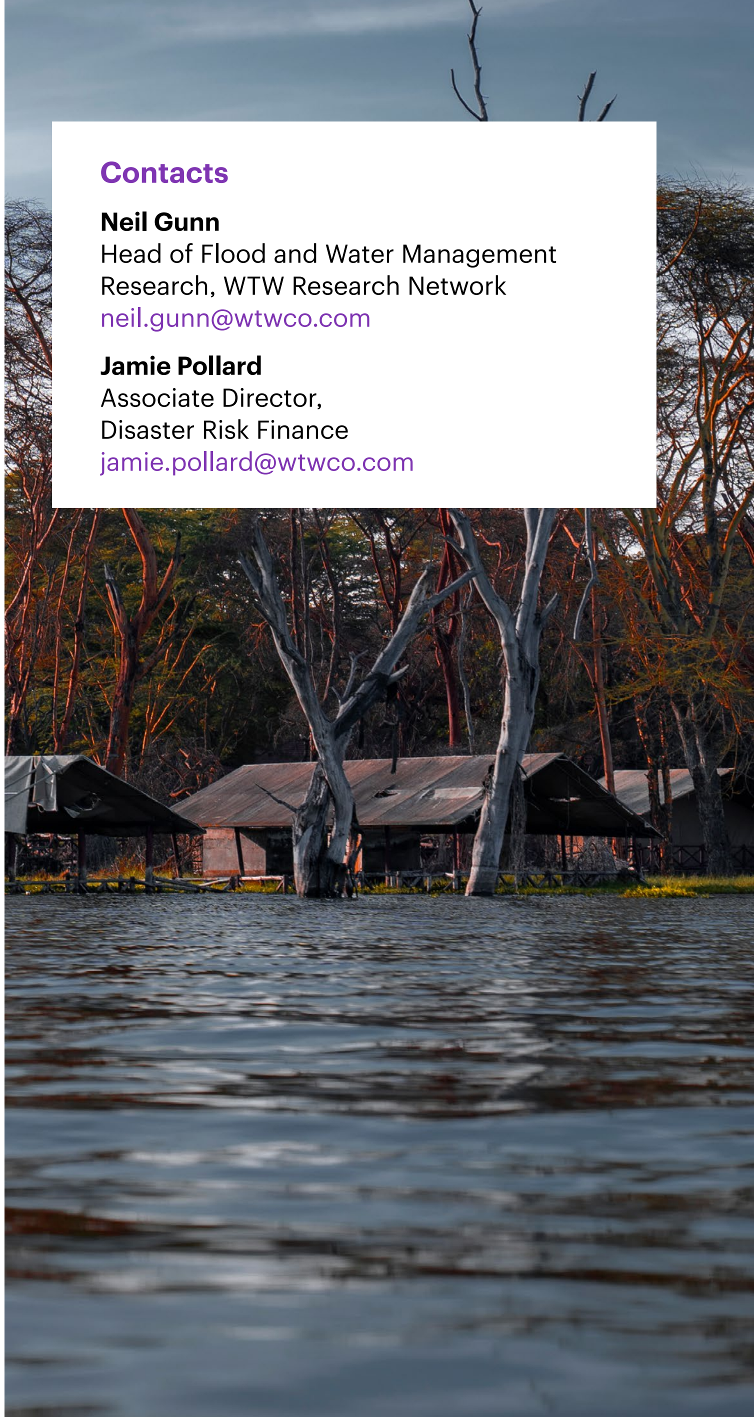
Conduct comprehensive assessments of exposure to flooding, including secondary risks such as dam failures and landslides. Analyze high-risk areas, particularly urban settlements with poor drainage and critical infrastructure.

Explore disaster risk financing

Explore parametric insurance options to facilitate rapid response and recovery from severe weather events, ensuring the quick release of funds based on predefined triggers.

Enhance infrastructure resilience

Take a risk-based approach to maintenance and enhancement of critical infrastructure. Improve urban drainage systems, maintain dams and embankments, and ensure resilience of essential services such as power and water treatment facilities.



Contacts

Neil Gunn
Head of Flood and Water Management Research, WTW Research Network
neil.gunn@wtwco.com

Jamie Pollard
Associate Director,
Disaster Risk Finance
jamie.pollard@wtwco.com

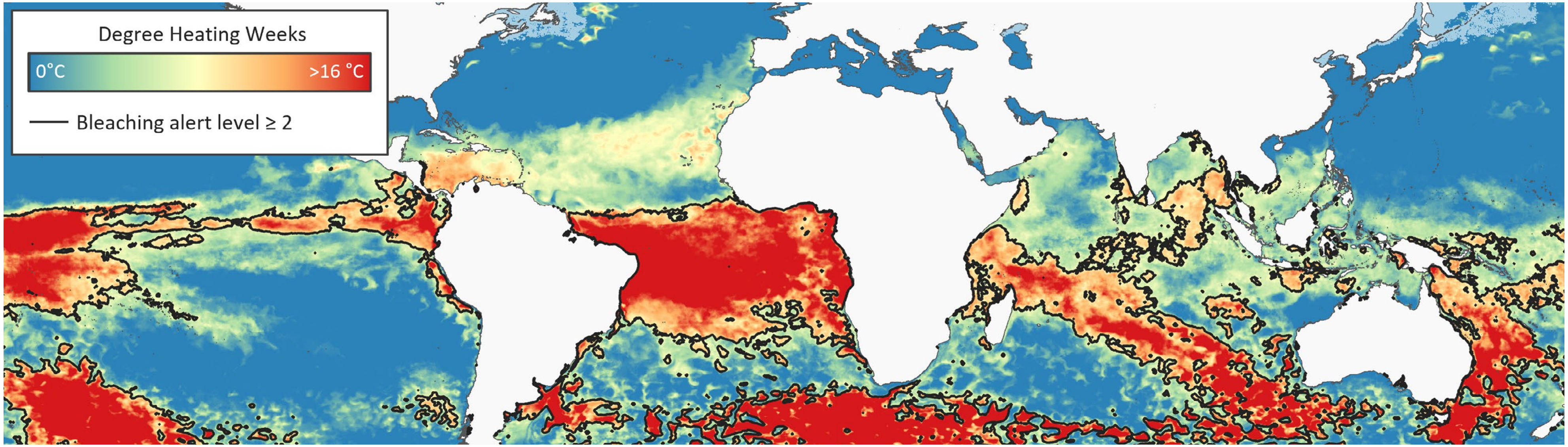
[5] WTW. Alternative Risk Transfer. (2024).
[6] Insurance Development Forum. Implementation progress update: Medellin flood, landslide, and earthquake protection. (2023)
[7] United Nations Office for the Coordination of Humanitarian Affairs. Eastern Africa heavy rains and flooding: Flash update 4. (2024).

3.9 Protecting coral reefs with parametric insurance in the face of increasing stressors

Marine ecosystems are experiencing the fourth recorded global coral bleaching event, the second in the past decade. As climate change intensifies, parametric insurance could play a crucial role in protecting these vulnerable ecosystems from escalating stresses.

On April 15, 2024, the Coral Reef Watch (CRW) at the U.S. National Oceanographic and Atmospheric Administration (NOAA) confirmed the world's fourth recorded global coral bleaching event — following those in 1998, 2010 and 2014 to 2017 — the second in the past decade.[1] A global bleaching event means significant bleaching across all ocean regions with warm-water corals: the Pacific, Atlantic and Indian oceans in both hemispheres (Figure 1). The latest event, which began in early 2023, is expected to surpass previous occurrences in both extent and severity.

Figure 1. **NOAA Coral Reef Watch's Degree Heating Weeks year to date, as of May 28, 2024. The area in black contour is within the Bleaching Alert Area Levels 2 – 5, which indicate regions that have experienced high levels of marine heat stress, which can lead to reef-wide coral bleaching and mortality.**



Data source: NOAA.[2]

[1] NOAA. NOAA confirms 4th global coral bleaching event. (2024).
[2] NOAA

Marine heat waves drive bleaching

The current bleaching has been driven by multiple interlinked factors. Chief among these are the record sea-surface temperatures in 2023, identified by the World Meteorological Organization as the hottest year on record for both the atmosphere and oceans,[3] with elevated temperatures continuing throughout 2024.[4] Marine heat waves, which significantly contribute to coral bleaching, are occurring against a backdrop of longer-term sea-surface temperature increases.

Local threats such as overfishing, sedimentation and runoff further weaken coral reefs, making them more susceptible to acute shocks such as tropical cyclones. These combined stressors mean that coral bleaching events, especially when coupled with extreme weather, can push ecosystems beyond their capacity to recover. This has potentially drastic consequences for marine biodiversity, food security and livelihoods.

The vital role of coral reefs

Coral reefs provide between US $375 billion and US $2.7 trillion in ecosystem services annually, crucial for the safety, nutrition, economic security, health and wellbeing of millions of people.[5,6] They protect an estimated 150,000 kilometers of shoreline in over 100 countries and territories, reducing wave energy by 97% and mitigating flood risk and erosion in coastal areas.[7,8] Coral reefs are also vital to ocean ecosystems, supporting 25% of all marine life. Around 96% of fishers are artisanal, working individually or in small communities, and rely on healthy reefs for roughly half of all global seafood.[9,10]

What happens when water temperatures increase?

Warm-water corals thrive in temperatures between 23°C and 29°C.[11] When temperatures exceed this range significantly or for extended periods, corals expel the algae that give them color, leaving behind a white, carbonate structure — a process known as bleaching. Reef recovery is not guaranteed and is less likely when combined with other stressors, and corals cannot migrate to cooler waters.

How do we measure coral bleaching?

Established in 2000, CRW monitors reef health. The Degree Heating Weeks (DHW) index measures heat stress intensity and duration on corals by summing temperature anomalies over a 12-week period, giving a total in degree weeks (Figure 1). At 4°C weeks, significant coral bleaching is likely, and at 8°C weeks, severe bleaching and significant reef mortality are expected.[12] Understanding coral reef composition is also crucial for assessing bleaching vulnerability, as coral species type and water depth influence outcomes, and some corals show adaptive capacity.

3 WMO. State of the Global Climate 2023. (2023).
4 Copernicus. Global temperature record streak continues – April 2024 was the hottest on record. (2024).
5 UNEP. Coral reefs: We continue to take more than we give. (2018).
6 World Economic Forum. How the world is coming together to save coral reefs. (2020).
7 Burke, L., & Spalding, M. Shoreline protection by the world's coral reefs: Mapping the benefits to people, assets, and infrastructure. Marine Policy, 146, 105311. (2022).
8 NOAA. The Importance of Coral Reefs. (2024).
9 ScienceDaily. Tracking small-scale fishers. (2022).
10 UN Trade & Development. Artisanal fishers are on the frontline of the overfishing crises. (2017).
11 Spalding, M.D., & Brown, B.E. Warm-water coral reefs and climate change. Science, (350), 6262. (2015).

Parametric insurance for coral reef protection

Parametric insurance is emerging as a promising tool to protect ecosystems. It offers rapid funding for protection and restoration efforts following damaging events, such as tropical cyclones, enabling conservationists to respond swiftly and effectively. For example, WTW has recently designed and implemented coral reef parametric solutions to address tropical cyclone impacts in the Caribbean and Pacific, including the Mesoamerican Reef with the MAR Fund, Hawaii with The Nature Conservancy and Fiji with the Vatuvara Foundation.

Exploratory efforts are also under way to assess the potential of parametric insurance to protect against or minimize coral bleaching. This could involve using the DHW index, with pre-agreed payouts being triggered when the index exceeds a certain threshold.

Two critical elements determine the feasibility of such insurance:

Insurability
This considers whether insurance markets would offer affordable policies underpinned by the DHW index. The high rate of ocean warming and increasing frequency of bleaching events may make policies prohibitively expensive; however, in geographies where marine heat waves are less connected to chronic ocean warming or where diversification of bleaching impacts from a heat wave are diversified, insurance pricing may be more affordable.

Payout use cases
This considers whether and how the rapid injection of capital could mitigate or minimize bleaching impacts. Several ideas are under development — for example, compensating fishers to not fish, deploying coral shades, administering marine probiotics and pumping cooler deep water. While a silver bullet solution is unlikely, tailoring interventions to a discrete location may yield local benefits.

While parametric insurance for coral bleaching faces significant challenges, it is likely to play a growing role in protecting against acute hazards such as tropical cyclones. This is driven by:

1. Changes to the frequency and severity of acute hazards
2. The improved recognition of the critical ecosystem services that coral reefs provide
3. The growing treatment of coral reefs as "natural infrastructure" and "natural capital," opening up the potential for new funding and enhanced protection

When considering the critical contribution of coral reefs to economies and livelihoods, alongside the multiple and intensifying stressors they face, risk reduction (e.g., ongoing conservation support) and risk transfer (e.g., parametric insurance) are likely needed to ensure survival of these ecosystems.

Implications for risk managers

Climate change risk assessments
Use earth observation data sets to assess climate-related risks faced by coral reefs and other marine ecosystems, including marine heat waves and tropical cyclone events. Use these insights to develop appropriate risk management strategies.

Disaster risk financing
Explore parametric insurance to provide rapid funding for ecosystem protection and restoration after damaging events.

Resilience planning
Recognize the value of ecosystems as "natural infrastructure" and "natural capital". Prioritize ongoing conservation support and risk transfer solutions to enhance resilience and ensure the survival of these critical ecosystems.

Contacts

Sarah Conway
Director, Disaster Risk Finance
sarah.conway@wtwco.com

Jamie Pollard
Associate Director,
Disaster Risk Finance
jamie.pollard@wtwco.com

[12] Coral Reef Watch. Degree Heating Week (DHW). (2022).

3.10 Learning from near misses: The April 2024 Northeast U.S. earthquake

By analyzing near-miss catastrophes such as the April 2024 Northeast U.S. earthquake, risk managers can uncover hidden risks and vulnerabilities, improving disaster preparedness and resilience.

Unanticipated events happen because recent history provides only a limited view of what can go wrong, leaving us vulnerable to risks we have not yet imagined; however, by looking more closely at near misses in the historical record, risk managers can uncover some of these hidden threats. Using a method called downward counterfactual analysis, businesses can better anticipate and mitigate potential risks by considering what could have happened if a near-miss disaster had turned out for the worse.

Downward counterfactual analysis

A counterfactual is a "what if" scenario used to examine hypothetical alternatives to historical events by slightly altering what happened — for example, "What if national governments had acted sooner to prevent the spread of the COVID-19 pandemic?" This is an example of upward counterfactual thinking, which looks at how outcomes could have been better with hindsight. According to psychology experts, it is less common for humans to engage in downward counterfactual thinking, which considers how situations could have been worse — for example, "How could the pandemic have been more devastating?" As a result, preventive actions are typically only taken in response to actual disasters rather than potential ones.[1]

In recent years, risk managers have been increasingly recognizing the benefits of downward counterfactual analysis for near misses, such as a hurricane narrowly avoiding a major city.[2] These types of scenarios are designed to help answer such questions as, "How could the financial loss have been worse?" and "What business actions should be implemented to prepare for such an event in the future?" This type of analysis not only helps with planning for similar future events but also strengthens overall risk management.

[1] Lloyds. Reimagining History: Counterfactual Analysis. (2017).
[2] Rye, C.J. & Boyd, J.A. Downward counterfactual analysis in insurance tropical cyclone models: A Miami case study. Hurricane Risk in a Changing Climate (2022).

The April 2024 New York City earthquake

An example of a recent near-miss event is the April 2024 Mw4.8 Northeast U.S. earthquake. The quake struck about 40 miles west of New York City, with the epicenter located near Tewksbury, New Jersey (Figure 1). The event produced widespread reports of low-to-moderate shaking across the region, including in New York City, northern New Jersey and eastern Pennsylvania; however, no major injuries or significant building damage were reported.

Although this earthquake was not particularly notable, it highlights the often-overlooked seismic risk in the northeastern part of the country. While damaging earthquakes are rare in this region, they can occur. Historical earthquakes include a Mw6.0 event in Boston (1755), a Mw5.8 event in northern New York State (1944) and two significant events in Greater New York City: Mw5.1 in 1737 and Mw5.3 in 1884.

Given this potential risk and New York City's status as a major population and economic center, it is important to explore downward counterfactuals of the recent earthquake. What if the event had been stronger or closer to New York City? How might this have affected the city's residents, businesses and economy? These questions help in understanding potential impacts and enhancing preparedness for future seismic events.

Using a U.S. earthquake catastrophe model, we analyzed hypothetical earthquakes affecting New York state that fall within the historically observed magnitude range of Mw4.5 to Mw5.5. Catastrophe models include stronger earthquake scenarios above Mw6 in New York state, but such events are deemed very rare, with return periods exceeding 500 years, and so are excluded from our analysis. Instead, we focus on understanding how small, plausible perturbations to the recent earthquake could have led to larger financial losses and worse outcomes.

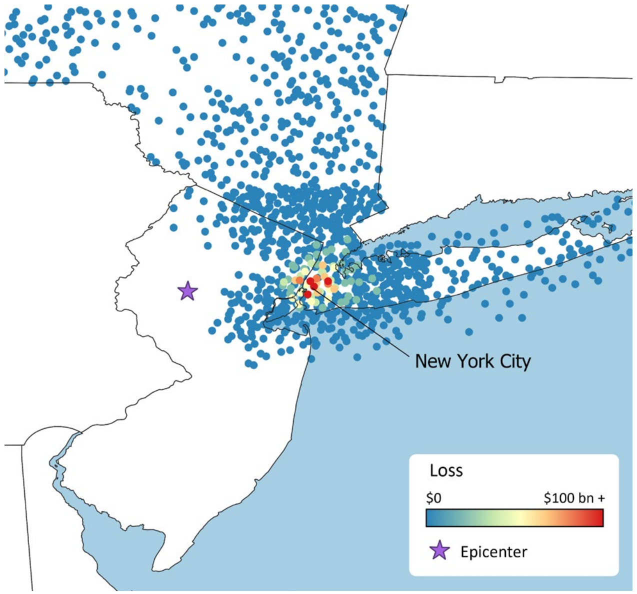
Figure 1 shows the locations of these modeled events, demonstrating how slight changes in the April 2024 earthquake's location and magnitude could have caused substantial insured losses. Many high-loss events are concentrated near New York City, with some scenarios exceeding $100 billion. This reflects the city's vulnerability due to many older buildings of unreinforced masonry that were constructed before the introduction of modern seismic design codes in 1995. Note that financial loss size also depends on rupture depth, with shallower ruptures causing more intense shaking, although this detail is not shown in Figure 1.

This analysis, which currently focuses solely on insured losses from property damage and business interruption based on the catastrophe model, could be expanded to include secondary effects. For example, a severe earthquake in New York City would likely disrupt transportation, utilities and healthcare facilities while also causing significant market volatility on Wall Street and affecting global markets.

Preparedness and resilience

The possibility of a damaging earthquake in New York City highlights the need for preparedness and resilience. Although earthquakes in the region are less likely than other natural catastrophes such as storms or floods, their potential consequences are significant and cannot be ignored. Insights from downward counterfactual analysis of the recent Mw4.8 event can help enhance the city's resilience, aiding risk managers, business owners and residents in better preparing for the future.

Figure 1. **Epicenter of the 2024 Northeast earthquake and insurance industry gross losses from Mw4.5 – Mw5.5 earthquakes affecting New York state in the Moody's RMS U.S. earthquake model. Each point represents the centroid of the rupture in the model. Only centroids in New Jersey and New York state have been included in the analysis.**



Data source: Moody's RMS.

Implications for risk managers

Uncover hidden risks

Analyze near misses to uncover hidden risks by evaluating how past events could have been worse, helping to anticipate and mitigate potential future disasters.

Estimate and mitigate financial impacts

Estimate financial impacts, including secondary effects such as transportation disruptions, utility failures and market volatility. Explore mitigating actions, such as (re)insurance or retrofitting, to reduce loss and damage.

Enhance preparedness and resilience

Use insights from near misses to enhance preparedness and resilience plans. Ensure adequate insurance coverage and robust business continuity plans are in place. Undertake seismic risk assessments and retrofit buildings and infrastructure.

Contacts

Jessica Boyd
Modelling Research and Innovation Lead, WTW Research Network
jessica.boyd@wtwco.com

Cameron Rye
Head of Modelling Research and Innovation, WTW Research Network
cameron.rye@wtwco.com

3.11 Record-breaking Hurricane Beryl in three figures

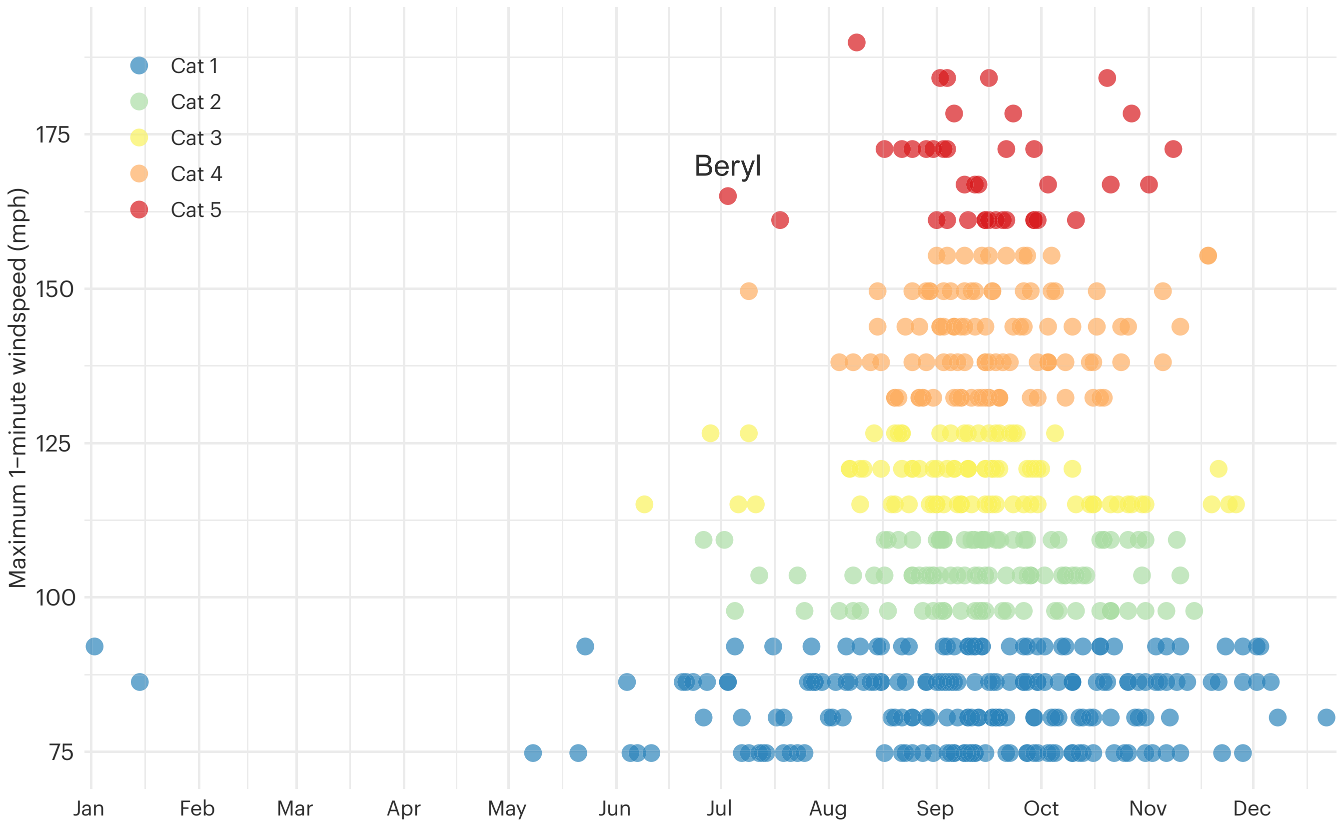
The 2024 hurricane season—predicted to be highly active—has begun dramatically with Beryl, which has broken numerous records. Here we show three figures which demonstrate Beryl's significance.

The first hurricane of the season, Beryl, which formed from a tropical depression on 28 June 2024, reached Category 5 at its peak intensity. It caused significant damage and loss of life while traversing the Caribbean. Additionally, Beryl made landfall on Mexico's Yucatan Peninsula as a Category 2 storm and later struck Matagorda Bay in Texas as a Category 1 storm.

Beryl set several records during its progression across the North Atlantic. It became the easternmost June hurricane and the second-southernmost major hurricane on record. Remarkably, within two days of forming, Beryl developed into the first-ever Category 4 hurricane recorded in the North Atlantic during the month of June. On July 1, Beryl's sustained winds reached 165 mph, making it the earliest Category 5 hurricane and the strongest North Atlantic hurricane on record for July (Figure 1).

As can be seen from Figure 1, such powerful storms typically develop later in the season, around mid-September, when sea surface temperatures peak. However, Beryl's formation and intensification defied these norms, standing out as a clear outlier compared to previous hurricanes.

Figure 1. **Maximum windspeeds for all hurricanes since 1900 in the HURDAT2 dataset and the day of the year in which the peak windspeeds occurred.**



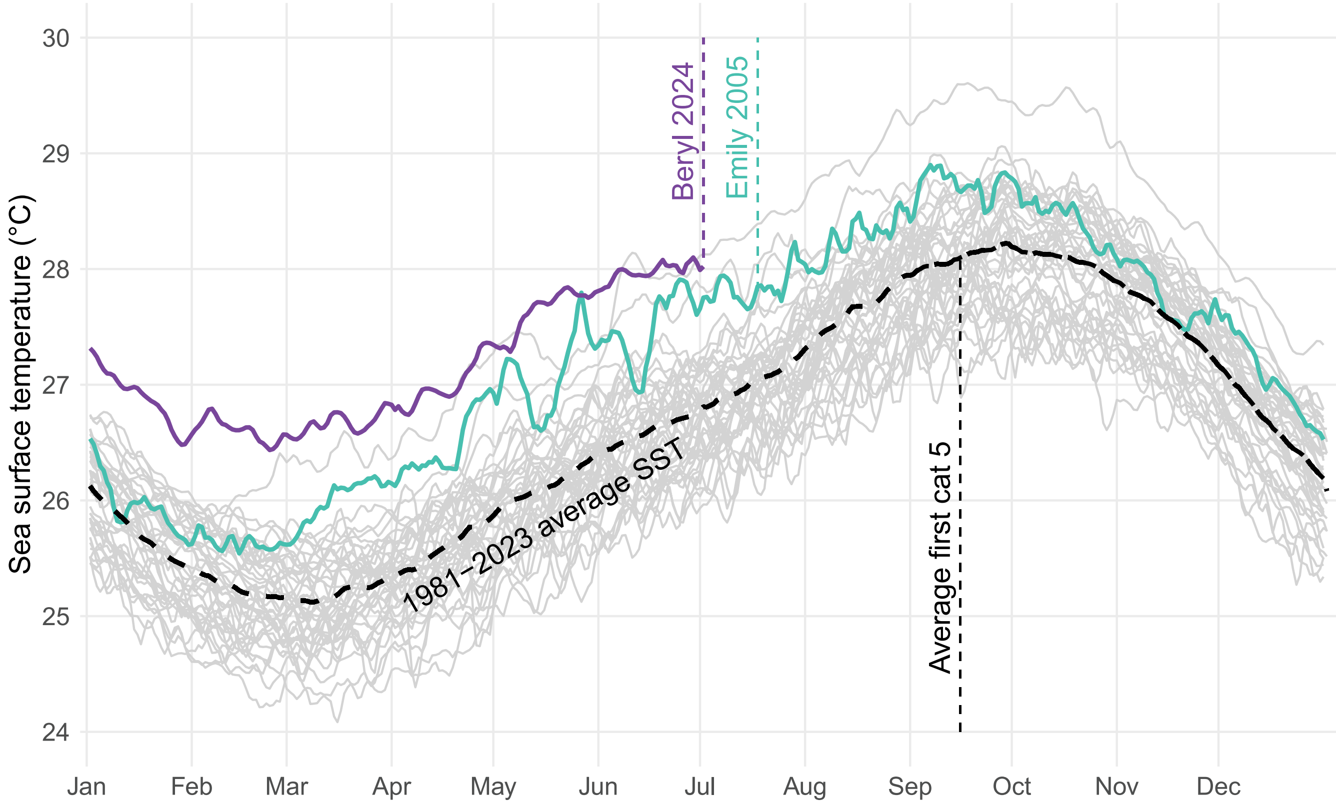
Data source: HURDAT2.[1]

[1] National Hurricane Center. HURDAT2 Atlantic hurricane database. (2024)

The emergence of a Category 5 hurricane in early July this year is unprecedented but not entirely unexpected, given the record warm sea surface temperatures within the hurricane main development region (MDR). This region spans the tropical Atlantic from 10°N to 20°N latitude and from 20°W to 85°W longitude. Figure 2 shows that MDR temperatures in early July 2024 have been comparable to the long-term average for the peak of the hurricane season.

Beryl surpassed the record for the earliest-forming Category 5 hurricane by over two weeks, a record previously held by Hurricane Emily in the notably active 2005 hurricane season. While that season also experienced above-average sea surface temperatures, they were not as high as those observed in July 2024.

Figure 2. **Sea surface temperatures in the hurricane main development region (defined here as 10°–20°N; 20°–85°W) for all years since 1981.**



Data sources: NOAA OISST and HURDAT2.[2]

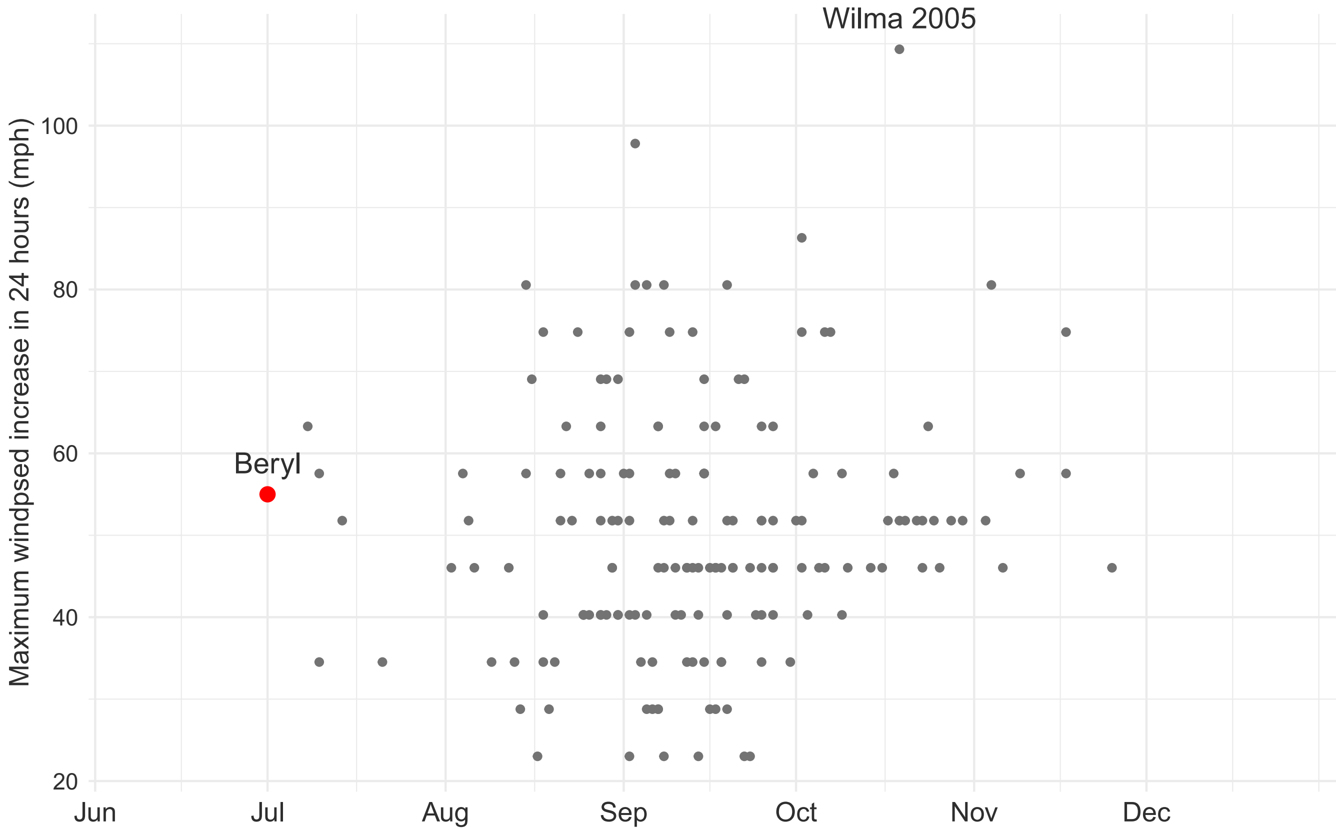
[2] NOAA. NOAA OI SST. (2024).

Another remarkable feature of hurricane Beryl's lifetime was the speed at which it intensified. "Rapid intensification" is commonly defined as an increase in windspeeds of 35 mph within a 24-hour period, and Beryl far exceeded this definition during one period of intensification in which the windspeeds increased by 55 mph in 24 hours.

Figure 3 shows that Beryl was the earliest hurricane to undergo a period of rapid intensification that culminated in category 3+ strength winds, and the only storm to do so in June. The hurricane which underwent the largest windspeed increase in 24 hours was hurricane Wilma in the highly active 2005 season. Recent studies suggest that the number of tropical cyclones undergoing rapid intensification is rising[3] and the intensification rate itself is increasing, particularly for the more extreme episodes such as those mentioned here.[4]

With ocean temperatures anticipated to stay at record highs throughout the season and the forecasted arrival of La Niña, the 2024 hurricane season is expected to be highly active (Section 4.1). As the peak of the hurricane season approaches, it will be interesting to see if the season continues to unfold as dramatically as it began.

Figure 3. **The maximum windspeed increase in a 24-hour period for all hurricanes in the HURDAT2 dataset since 1900 for which the episode of rapid intensification culminated in major (category 3+) hurricane windspeeds.**



Data source: HURDAT2.[1]

Contacts

Jessica Boyd
Modelling Research and Innovation Lead,
WTW Research Network
jessica.boyd@wtwco.com

[3] Zhao, H., Duan, X., Raga, G. B. & Klotzbach, P. J. Changes in characteristics of rapidly intensifying western north Pacific tropical cyclones related to climate regime shifts. Journal of Climate 31, 8163–8179 (2018).
[4] Garner, A. J. Observed increases in North Atlantic tropical cyclone peak intensification rates. Sci Rep 13, 16299 (2023).

Outlook

4.1 Oceanic signals raise the ceiling on the 2024 North Atlantic hurricane season

A second consecutive year of record heat in the North Atlantic Ocean, along with developing La Niña conditions, is expected to boost hurricane activity in the basin. Will most storms once again stay out to sea, or should we expect a higher portion to make landfall?

An unprecedented set of oceanic warning signals

The big signals for this year's North Atlantic hurricane season lie in the oceans. Unusually high heat arrived in the North Atlantic in early 2023 and has persisted into 2024. Record sea surface temperatures have occurred somewhere in the North Atlantic every day since last summer. Indeed, parts of the North Atlantic were as hot in May 2024 as they typically are in August. This heat is already contributing to impacts with torrential flooding rains across South Florida in mid-June.

It's not just the ocean surface that is unusually hot. The high heat also extends a few hundred meters beneath the surface. This deep column of hot water is essential to power the most intense hurricanes. Alarmingly, the pattern of heat across the North Atlantic Ocean closely resembles the pattern that has historically produced the most active seasons.

Meanwhile, over in the equatorial Eastern Pacific Ocean, a rapid cooling is under way signaling the imminent arrival of La Niña. History tells us that La Niña boosts seasonal hurricane numbers by limiting strong winds aloft over the tropical North Atlantic, which would otherwise disrupt and break up developing storms.

With a total of 20 named storms, 2023 had the fourth highest tally in recorded history, behind only 2020, 2005 and 2021.

Last year, the looming issue for hurricane forecasters was whether the record heat in the North Atlantic Ocean would win out over the hurricane-suppressing effect of El Niño. In the end, the North Atlantic's influence was clearly the strongest.

This year there is no such competition. I expect the Atlantic and Pacific oceans to work together in the same direction and create an active — perhaps even hyperactive — hurricane season. However, we must also remember that hurricane forecasters are working in uncharted territory. We have never experienced such exceptionally hot conditions in the North Atlantic at the same time as an expected La Niña. Because of the unprecedented heat in the North Atlantic, hurricane experts who forecast the expected number of storms using an analog approach are struggling because none of the previous years have similar conditions.

[1] Klotzbach, P.J., Bell, M.M., DesRosiers, A.J., and Silvers, L. Extended Range Forecast of Atlantic Seasonal Hurricane Activity and Landfall Strike Probability for 2024. Issued June 11, 2024.

What can we say about landfall?

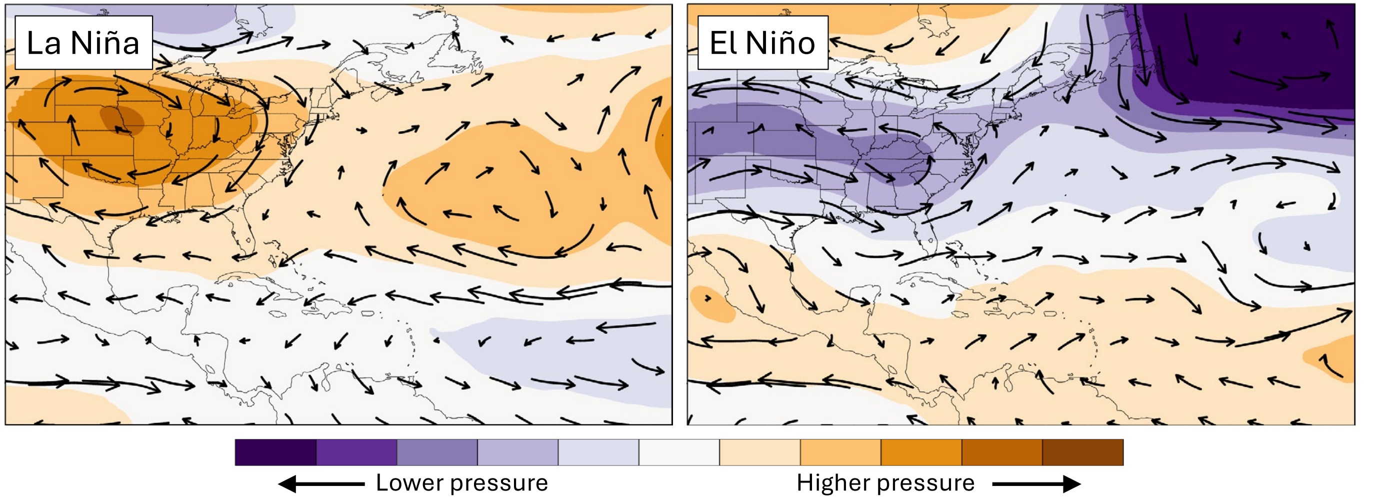
A critical component of seasonal storm activity is how much of it will affect land. Yet this is often overlooked because forecasting seasonal landfall activity is so difficult. The National Oceanic and Atmospheric Administration does not comment on landfall in its seasonal outlooks.[1] Its position is that landfall is largely determined by weather patterns as storms get closer to the coast and that these daily weather patterns cannot be predicted in advance of the season.

Colorado State University (CSU) does produce predictions of the probability of storms making landfall along the Atlantic Coast of the U.S.[2] Those landfall forecasts are founded on the observation that storm activity in the western half of the North Atlantic is usually higher during La Niña than El Niño. This association[3] is likely due in part to the fact that atmospheric circulation patterns over the North Atlantic tend to steer storms toward the American coastline during La Niña and away from the coastline during El Niño (Figure 1). In 2023, for example, a strong El Niño combined with a weakened subtropical high to keep most storms away from the coast and safely out at sea.

As of June 2024, the North Atlantic subtropical high seems to be getting stronger, and this trend is one of the factors underlying CSU's forecast of higher-than-normal landfall risk. At present, CSU's group anticipates the probability of at least one major hurricane making landfall in the U.S. to be 50% higher than the average hurricane season. But again, forecasting hurricane landfall is more difficult than predicting the total number of storms. The uncertainty in seasonal landfall is reflected in the large range of U.S. landfalling hurricane numbers among CSU's analogue years (1878, 1926, 1998, 2005, 2010, 2020) of between zero (in 2010) and six (in both 2005 and 2020). And these forecasts also apply to very broad geographic areas: Landfall forecasts are available for the entire U.S. Atlantic Coast, the East Coast and the Gulf Coast. It's not currently possible to make landfall forecasts in advance of the season specific to particular states or communities.

There is much to learn about our ability to forecast steering flow and landfall activity in advance of the season. Each year, only a few storms occur, providing us with a limited amount of data, which makes it difficult to identify patterns and relationships; however, emerging evidence shows that frequencies of some daily weather patterns may be somewhat predictable in advance of a season.[4]

Figure 1. **Anomalous summer average steering patterns during historical La Niña (left) and historical El Niño (right) years over the period 1980 – 2022. During La Niña, anomalous high pressure over the mid-latitudes produces anomalous steering flow toward the U.S. During El Niño the opposite anomaly pattern steers storms away from the U.S.**



Data source: The European Center for Medium-Range Weather Forecasts and the National Oceanic and Atmospheric Administration.

[1] Rosencrans, M., Wang, H., Harnos, D., Blake, E., Landsea, C., Pasch, R., Goldenberg, S., and Lopez, H. NOAA 2024 Atlantic Hurricane Season Outlook. Issued May 23, 2024.
[2] Klotzbach, P.J., Bell, M.M., DesRosiers, A.J., and Silvers, L. Extended Range Forecast of Atlantic Seasonal Hurricane Activity and Landfall Strike Probability for 2024. Issued June 11, 2024.
[3] Colbert, A. J. & Soden, B. J. Climatological variations in North Atlantic tropical cyclone tracks. J. Clim. 25, 657–673 (2012).
[4] Prein, A. F. et al. Sub Seasonal Predictability of North American Monsoon Precipitation. Geophys. Res. Lett. 49, e2021GL095602 (2022).

Storm genesis locations may also be important in determining landfall risk. Indeed, new evidence is emerging over many seasons that genesis location is more important than steering flow for determining landfalling storm tracks,[5] and there is opportunity to improve our ability to forecast preferred genesis regions before the start of the hurricane season.

Given the explosion of advanced statistical techniques in the atmospheric sciences, we can expect to see a proliferation of machine-learning-based seasonal hurricane predictions that will no doubt start to produce regional landfall predictions. Improving our ability to estimate the number of storms that cross over to land and their likely trajectories is an exciting and important emerging priority for hurricane research.

In summary, all signals are pointing to a very active season. Perhaps one factor that could make a dent in the forecast is Saharan Air Layer outbreaks. These could mitigate some of the record warming, and the dry and dusty air could interfere with storm formation. Irrespective of any potential mitigating factors, the ceiling on the Atlantic hurricane season numbers has never been so high.

Implications for risk managers

Scenarios for high hurricane activity

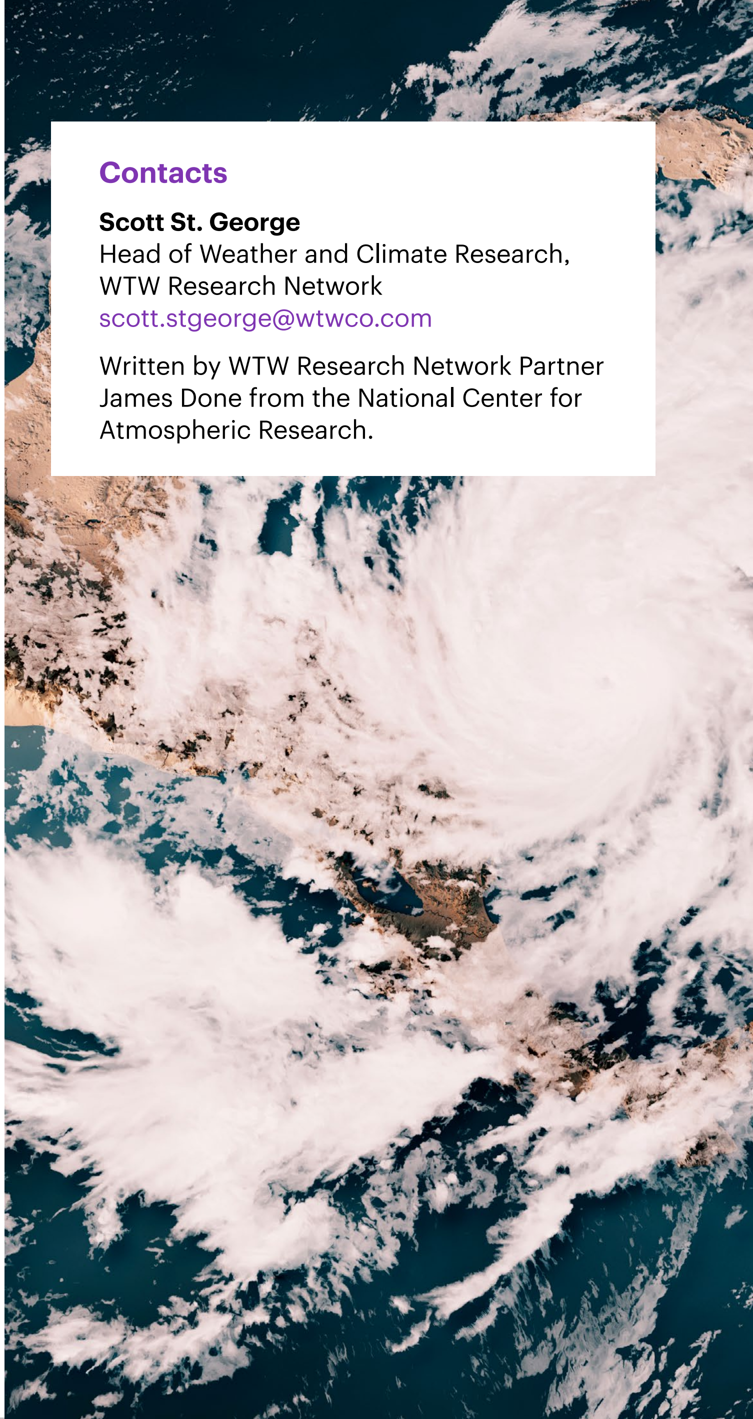
Prepare comprehensive 'what-if' scenarios to quantify the heightened physical risks associated with a hyperactive hurricane season. Develop a contemporary view of hurricane exposure that integrates the compound effects of exposure growth, inflation, and climate.

Identify hidden risks

Prepare realistic estimates of potential losses that reflect direct damages to physical assets, operational and supply chain disruptions, and complications from emergency measures.

Resilience efforts

Support and incentivize mitigation efforts such as the installation of storm shutters and retrofitting buildings for wind resistance.



Contacts

Scott St. George
Head of Weather and Climate Research,
WTW Research Network
scott.stgeorge@wtwco.com

Written by WTW Research Network Partner James Done from the National Center for Atmospheric Research.

[5] Kortum, G., Vecchi, G. A., Hsieh, T. L. & Yang, W. Influence of Weather and Climate on Multidecadal Trends in Atlantic Hurricane Genesis and Tracks. J. Clim. 37, 1501–1522 (2024).

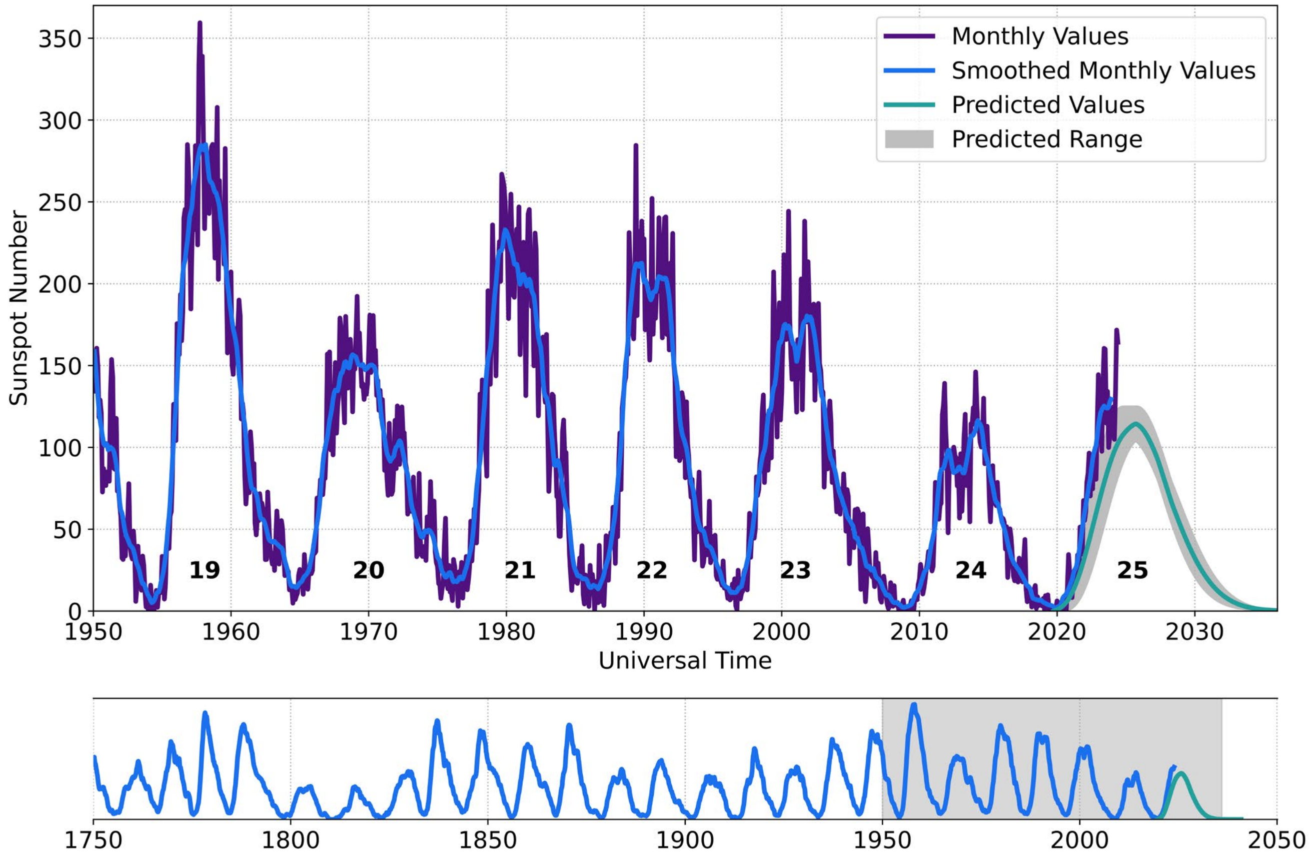
4.2 The gray swan in our sky: The multibillion-dollar threat of solar flares

As we approach a new solar maximum, the historic Carrington Event and its potential parallels to contemporary natural catastrophes underline the significant economic and operational impacts that solar activity can have on our modern world.

Like earthquakes that gradually build up stress before releasing it in sudden ruptures, the sun undergoes similar cycles of mounting magnetic tension. This cyclical solar activity occurs about every 11 years, marked by phases of low and high activity, known respectively as solar minimum and solar maximum. During the solar maximum, the sun unleashes powerful forces, including solar flares and coronal mass ejections, which can significantly disturb Earth's magnetosphere, leading to geomagnetic storms that may disrupt communication systems, power grids and satellite operations.

Sunspots — dark patches on the sun caused by magnetic fluctuations — are vital indicators of the sun's magnetic activity and help predict the phases of the solar cycle. We are currently in solar cycle 25, which began in December 2019 and is expected to reach its peak around July 2025 (Figure 1).

Figure 1. **Solar cycle sunspot number progression since 1950 (top) and since 1750 (bottom).**



Data source: Space Weather Prediction Center.

Earthly consequences

Readers fortunate enough might have observed visual displays of auroras in May 2024. This was a direct result of the most powerful solar storm since October 2003, reflecting the heightened solar activity that marks the ramp-up toward the solar maximum phase of the cycle. While these solar outbursts are spectacular to observe, they also have the power to disrupt our technology-dependent society significantly. Recent disruptions include:

- **Satellite failures** In February 2022, two coronal mass ejections caused up to 40 Starlink satellites to reenter Earth's atmosphere shortly after launch,[1] costing about US $25 million.
- **Communication disruptions**
  In December 2023, one of the largest ever solar radio events disrupted radio aircraft communications.[2] In November 2015 (solar cycle 24), a solar storm closed Sweden's airspace for nearly an hour, disrupting flights.[3] One study indicates that during solar flares, flight departure delay time increases on average by 21% (eight minutes).[4]
- **Power outages**
  A major coronal mass ejection in March 1989 (solar cycle 22) significantly interfered with the U.S. power grid and caused a nine-hour power failure in Quebec, costing US $13.2 million.[5]

These incidents underscore the capacity for substantial economic disruptions and considerable financial pressures on businesses, governments and particularly the insurance industry.

Not quite black or white

Solar flares epitomize the concept of a gray swan event. Unlike black swans, which are unpredictable and exceptionally rare events with severe consequences (such as the 2011 Tōhoku earthquake), gray swans like solar flares are not entirely unforeseen. They are characterized by some level of predictability based on historical patterns or scientific forecasts.

The challenge with solar flares lies in their irregular occurrence and significant variance in intensity, making accurate predictions difficult. Their unpredictability and the scarcity of recent precedents complicate financial impact assessments. Consequently, existing underwriting processes inadequately account for the risks posed by solar flares due to the lack of a reliable predictive model and limited historical loss experience.

The most powerful solar storm in known history

The strongest event in known history — the "Carrington Event" — occurred on September 1 and 2, 1859 (solar cycle 10). Named after the British astronomer who reported it, the storm caused telegraph systems in Europe and North America to fail. Some operators were still able to transmit messages even after disconnecting power, as the geomagnetic storm induced electrical currents in the telegraph wires. That evening, the auroras were seen worldwide. In Montería, Colombia, José Inés Ruiz painted an exceptional scene: "pitch-black storm-clouds furrowed by blazes of strange resplendence" and "immense flaming tongues and blinding igneous globules … giving the impression of a hundred erupting volcanoes."[6]

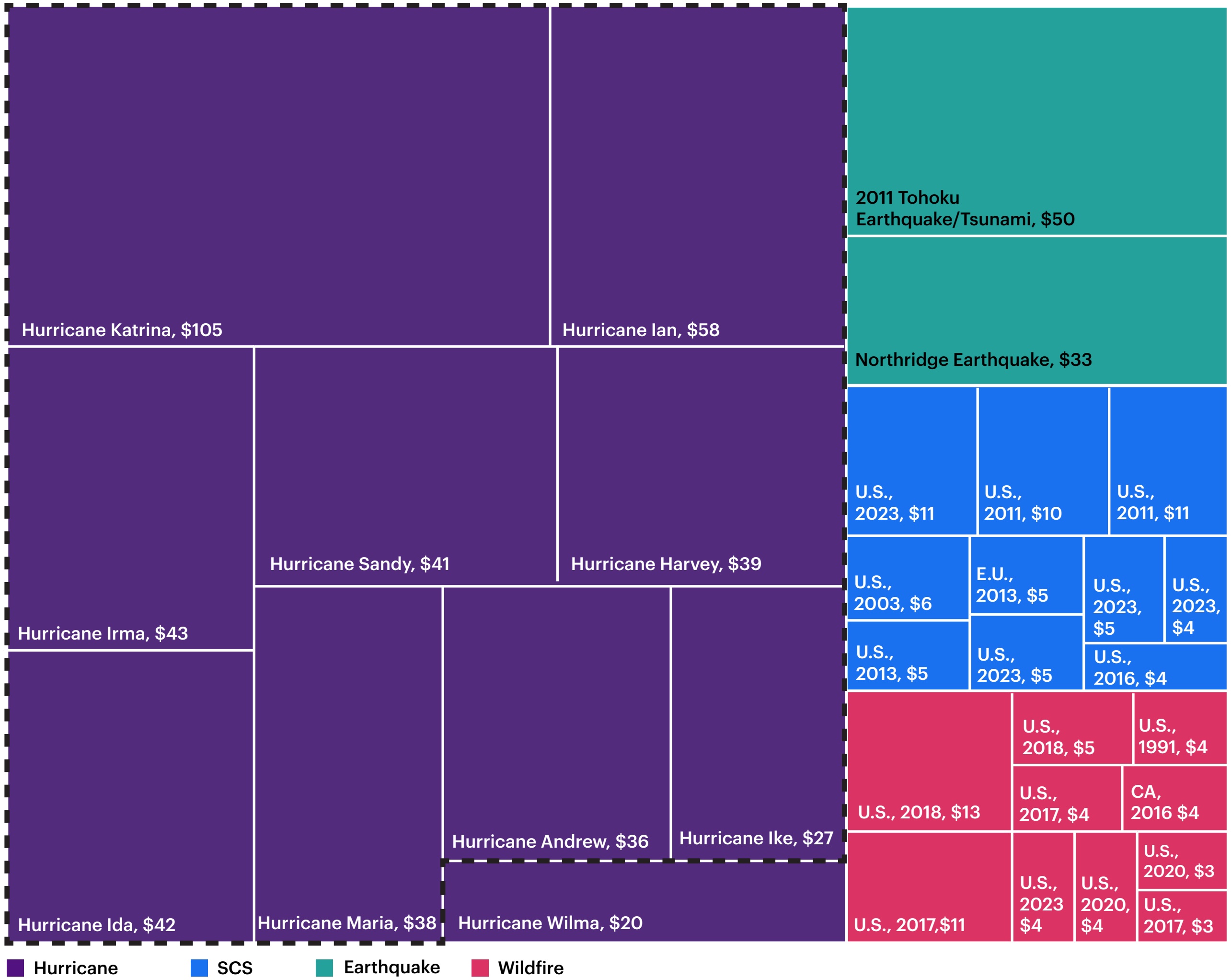
Now more than 130 years later, our planet has yet to experience a solar storm comparable to the Carrington Event (Table 1). But we should not assume the odds of a similar event in our future are zero. According to tree rings, the Earth has been hit by at least six solar events larger than Carrington, by an order of magnitude or more, during the past 10,000 years.[7]

Table 1. **Selected solar storms to have impacted Earth and their corresponding disturbance storm time index, a measure quantifying the intensity of geomagnetic disturbances caused by solar activity (in nanoteslas; nT).**

Event (solar cycle)	Disturbance Storm Time Index (nT)
September 1859 Carrington Event (10)	–1275 ±475
February 1872 Chapman–Silverman storm (11)	~–834
May 1921 geomagnetic storm (15)	–907 ±132
August 1972 solar storms (20)	–154
March 1989 geomagnetic storm (22)	–589
July 2000 Bastille Day event (23)	–301

[1] LiveScience. Geomagnetic storm sends 40 SpaceX satellites plummeting to Earth. (2022).
[2] NOAA. Strongest Solar Flare of Solar Cycle 25. (2023).
[3] CBC. Solar storm knocks out flight control systems in Sweden, grounds planes. (2015).
[4] Xu, X. H., et al. Characteristics of flight delays during solar flares. Scientific Reports, 13(1), 6101. (2023).
[5] Bolduc, L. GIC observations and studies in the Hydro-Québec power system. Journal of atmospheric and solar-terrestrial physics, 64(16), 1793-1802. (2002).
[6] cited in Cárdenas, F. M. et al. The grand aurorae borealis seen in Colombia in 1859. Advances in Space Research, 57(1), 257-267. (2016).
[7] Zhang, Q., et al. Modelling cosmic radiation events in the tree-ring radiocarbon record. Proceedings of the Royal Society A, 478(2266), 20220497. (2022).

Figure 2. **List of comparative natural disasters by estimated insured losses. Values 2024 US$ billions, adjusted for inflation. Note, these figures do not account for change in exposure growth. The dotted black box represents approximately $433 billion, the potential maximum size of a modern-day Carrington Event.**



Financial footprints

With advancements in technology and increased dependency on electronic systems, a modern-day Carrington Event could cause unprecedented economic and societal disruptions. Estimating the potential impacts on vehicles, property and power grids is challenging due to limited historical precedents and modeling studies; however, current best estimates indicate that U.S. insurance industry losses, were such an event to occur today, could range between US $71 billion and $433 billion (in 2024 US$),[8] with global losses significantly higher.

To put these figures into perspective, consider other notable natural disasters (Figure 2):

- **Hurricane Katrina (2005)** resulted in insured losses of approximately $105 billion (in 2024 US$).
- **Insured losses for Hurricane Ian (2022)** and the 2011 **Tōhoku earthquake** sit at the lower end of the Carrington loss range.
- **Total insured losses from all natural catastrophes in 2023** exceeded US $100 billion.

The global GDP at risk from a Carrington-style event is estimated to range from US $183 billion to over $1 trillion (in 2024 US$).[8] The wide range of potential outcomes demonstrates the significant financial implications that solar flares could impose. Unlike other natural disasters, which are often regionally confined, the impact of a Carrington-style event would be global — directly affecting supply chains and disconnecting large populations from power for weeks or months.

[8] Oughton, E., et al. Helios solar storm scenario. Cambridge Risk Framework series. (2016).

A near miss

As we approach the peak of solar cycle 25, the potential for severe solar storms and their impact on the insurance industry and global economy intensifies. Although the likelihood of a catastrophic solar event occurring remains low, it is not zero.

A near miss in July 2012 highlights the risk: A solar storm of comparable magnitude to the Carrington Event erupted,[9] but Earth was not in the line of impact. Had it occurred nine days earlier, Lloyd's estimated an economic cost ranging from US $0.8 trillion to $3.5 trillion (in 2024 US$).[10] The small but significant chance (4%)[11] of a direct hit from this event emphasizes the need for robust preparedness as we near a solar maximum.

Comparing solar activity to familiar natural hazards highlights the unique challenges of these gray swan events. Unlike well-documented and often localized natural disasters, severe solar storms are less frequent and more far-reaching. Their implications include:

- Damage to trans-oceanic communication cables, disrupting global communications
- Satellite failures causing significant data losses
- Disruptions in global navigation systems impacting air and sea navigation

Each of these scenarios poses substantial risks to global connectivity and, by extension, the global economy.

Ultimately, when it comes to solar storms and their potential to disrupt our modern world, it's not a matter of if, but when.

Implications for risk managers

Scenario analysis
Develop scenarios, such as a repeat of the Carrington Event, to understand and quantify exposures to geomagnetic storms and potential financial losses, including both direct and indirect impacts.

Disaster preparation
Implement measures to mitigate the risks associated with solar flares. Develop contingency plans for rapid response and ensure risk management frameworks account for the potential scale and scope of solar flare impacts.

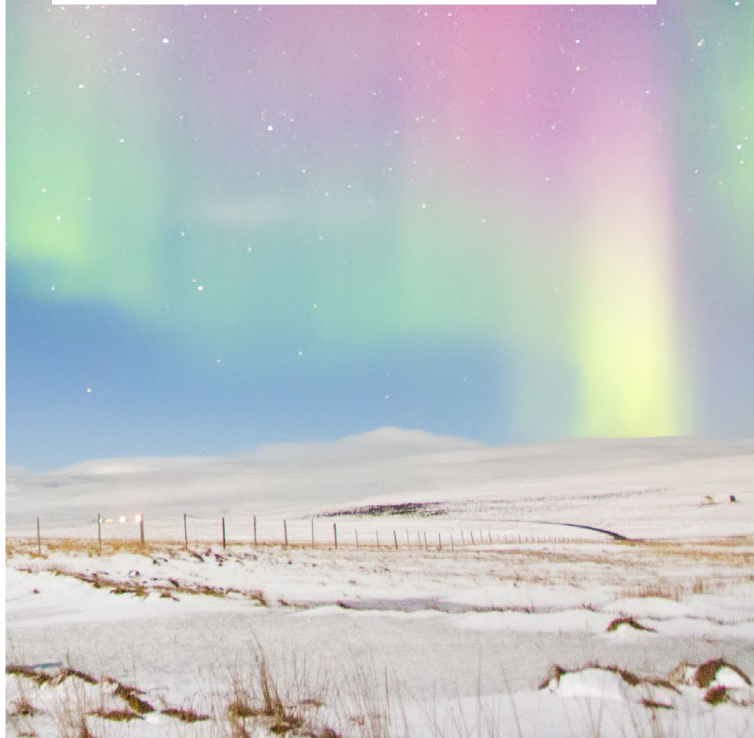
Enhance resilience
Use insights from near-misses to enhance preparedness and resilience plans. Ensure adequate insurance coverage and robust business continuity plans are in place.

Contacts

Daniel Bannister
Weather & Climate Risks Research Lead, WTW Research Network
daniel.bannister@wtwco.com

Scott St. George
Head of Weather & Climate Risks Research, WTW Research Network
scott.stgeorge@wtwco.com

Hélène Galy
Managing Director of WTW Research Network, Head of People Risks Research, WTW Research Network
helene.galy@wtwco.com



[9] Liu, Y. D., et al. Observations of an extreme storm in interplanetary space caused by successive coronal mass ejections. Nature Communications, 5(1), 3481. (2014).
[10] Lloyd's of London. Solar Storm Risk to the North American Electric Grid. (2013).
[11] Lloyd's of London. Reimagining history: Counterfactual risk analysis. (2017).

4.3 Leveraging climate risk reporting for building resilience and strategic planning

Climate risk reporting should be seen as more than just a compliance activity; instead, it should be leveraged for strategic planning to preserve long-term value and enhance resilience. Effective assessment and management of climate risks can only be achieved through cross-functional collaboration.

Staying current with climate reporting can be challenging as a diverse array of standards and frameworks has emerged. As climate reporting is becoming increasingly stringent, organizations will have to make significant investments in data collection and compliance processes. This article provides an update on some of the most notable climate risk reporting frameworks and highlights the opportunity to leverage these requirements for strategic planning and building resilience using a cross-functional approach.

Climate risks can be grouped into two categories: physical risks, which stem from direct impacts of climate change such as extreme weather events, and transition risks, which arise from the shift to a low-carbon economy. Addressing these risks not only meets regulatory requirements but also uncovers opportunities to build resilience to climate change, operational efficiencies and competitive advantages in the low-carbon transition.

Importance of cross-functional collaboration

Cross-functional collaboration is essential for comprehensive climate risk reporting and enabling a shared view of climate risk and opportunities across the organization. Leveraging compliance and reporting frameworks — including the SEC Climate Rule, ESRS E1 and IFRS S2 (see sidebar) — can drive this collaboration, ensuring that sustainability goals align with financial objectives and stakeholder expectations.

Sustainability and Finance teams play a crucial role in identifying climate risks and conducting scenario analyses to evaluate the resilience of the company's operations and strategy. Risk management, including traditional and enterprise approaches, helps inform the prioritization and execution of strategies to mitigate, transfer or avoid risks. These strategies include optimizing insurance, diversifying suppliers and implementing adaptation measures (e.g., elevating buildings, installing flood walls or reinforcing structures against extreme winds). Legal teams ensure compliance with new regulations. Climate risk should also inform new site selection and identification of opportunities from shifting weather patterns and from the transition, such as low-carbon technologies and products.

Working across teams, organizations can establish a common understanding of climate risk and align actions, strategy and disclosure. Failing to adopt a cross-functional approach when complying with these requirements can lead to duplicating data collection efforts and inaccurate assessments of climate risks and opportunities — and potential exposure to liability risk. An uncoordinated approach can also be more resource intensive as different teams collect the same data points using varying methodologies.

Advantages of effective climate risk management

Competitive advantages can be gained from effective climate risk management. By staying ahead of regulatory requirements, companies can avoid fines and legal liabilities and adapt early to regulatory changes to avoid disruptions to their operations. Embedding climate risk considerations into the core business strategy also has key advantages. With investors relying more on climate disclosures to make investment decisions, organizations with robust climate reporting may attract more investment by enhancing resilience to climate change and showcasing long-term value in the low-carbon transition. The proactive approach to climate risk management may also result in more favorable insurance terms, as insurers value the reduced risk exposure and improved risk mitigation strategies.

Conclusion

In conclusion, while climate risk reporting may initially seem like a compliance burden, strategically leveraging these frameworks can drive long-term benefits, including improved overall resilience, reduced operational costs and enhanced investor confidence. Cross-functional collaboration is essential to ensure comprehensive and accurate climate risk disclosures and to maximize these benefits. By integrating insights from Sustainability, Finance, Risk and Legal teams, companies can achieve more-effective climate risk management and better align their strategies with regulatory expectations and market demands.

Implications for risk managers

Form a cross-functional team
Include representatives from Sustainability, Risk, Finance and Legal to ensure comprehensive climate risk reporting and strategic alignment.

Conduct a gap analysis
Identify current gaps in your climate risk reporting processes compared with new regulatory requirements and industry best practices and develop a plan to address gaps.

Invest in data collection and management
Implement robust data collection and management systems to ensure accurate and consistent reporting.

Engage with stakeholders
Regularly communicate with investors, regulators and other stakeholders to keep them informed of your climate risk management efforts and solicit feedback.

Overview of key climate reporting frameworks

CSRD European Sustainability Reporting Standards (ESRS) E1

The European Union's (EU's) Corporate Sustainability Reporting Directive (CSRD) expands on the scope and robustness of the disclosures required by its predecessor, the Non-Financial Reporting Directive (NFRD). While carbon emissions remain a focus, all large and listed EU businesses — including qualifying EU subsidiaries of non-EU companies — must report on additional environmental aspects such as pollution, water usage, waste management and biodiversity. Specifically, under the climate change standard (ESRS E1), organizations must disclose climate-related risks, detailing how these risks affect their operations, financial performance and resilience strategies. A key concept of CSRD reporting is double materiality, which requires organizations to consider how their business operations impact the society and the environment around them and how sustainability issues can affect their financial performance.

ISSB International Financial Reporting Standards (IFRS) S2

In June 2023, the International Sustainability Standards Board (ISSB) published two sustainability reporting standards: IFRS S1 and IFRS S2. Effective January 1, 2024, IFRS S1 (General Requirements for Disclosure of Sustainability-related Financial Information) sets out the overarching principles and requirements for sustainability-related financial disclosures. It serves as a foundation that supports climate-specific standard IFRS S2 (Climate-related Disclosures), which focuses on how climate-related risks could reasonably be expected to impact the company's financial position and performance.

IFRS S1 and S2 have been adopted in 168 jurisdictions, including 15 of the G20. Countries in Asia Pacific — such as Singapore and Hong Kong, as well as Japan, a G20 member — are moving to adopt.

Certain reporting frameworks, including the ESRS E1 and IFRS S2, may also require participants to conduct scenario analysis. This can help companies better understand the potential risks and opportunities associated with different climate-related scenarios, enabling better strategic planning and risk management.

SEC Climate Rule

The U.S. Securities and Exchange Commission (SEC) Climate Rule aims to provide stakeholders with consistent and comparable information about how organizations are managing their climate-related risks and opportunities. Despite the ruling being paused in April due to legal challenges, SEC registrants have already begun to consider how they will disclose climate-related risks that have had or are reasonably likely to have a material impact on their business strategy, operations or financial condition.

Contacts

Holly Teal
Climate Practice Lead, North America
holly.teal@wtwco.com

Grace Youell
Associate Director, Climate Practice
grace.youell@wtwco.com

Tae Young Oh
Analyst, Work & Rewards
taeyoung.oh@wtwco.com

About WTW
At WTW (NASDAQ: WTW), we provide data-driven, insight-led solutions in the areas of people, risk and capital. Leveraging the global view and local expertise of our colleagues serving 140 countries and markets, we help you sharpen your strategy, enhance organizational resilience, motivate your workforce and maximize performance. Working shoulder to shoulder with you, we uncover opportunities for sustainable success — and provide perspective that moves you. Learn more at wtwco.com.

wtwco.com/social-media

Copyright © 2024 WTW. All rights reserved.
WTW_150550 0724

wtwco.com