In collaboration with Allianz

WORLD ECONOMIC FORUM

Insuring Against Extreme Heat: Navigating Risks in a Warming World

WHITE PAPER

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Images: Getty Images

Contents

Foreword

Christopher Townsend
Member, Board of Management, Allianz

Prolonged periods of extreme temperatures and increasingly frequent and severe heatwaves have ushered in an age of "global boiling". In contrast to headline-grabbing hurricanes and earthquakes and their immediately visible catastrophic effects, extreme heat has unleashed a host of perils on populations, communities and infrastructure in a silent, incremental and mostly unnoticed way.

The World Economic Forum's Extreme Heat Resilience Consortium – which brings together the global risk and insurance industry, environmental groups and climate experts – is pleased to present this paper on the wide-ranging effects of extreme heat, which include chronic disease, heightened mortality, reduced economic productivity, drought, wildfire, infrastructure degradation and supply chain fragility. The paper also introduces strategies to enhance society's preparedness and resilience in the face of this growing climate-related risk.

Most importantly, this paper serves as a reminder of our shared responsibility. Building resilience to extreme heat demands the use of all societal levers. The insurance industry can respond to this complex challenge of diffuse and long-tail impacts as a proactive, collaborative partner. We must bring a spirit of community and collaboration and a relevant portfolio of skills and assets to the table.

As risk and capital allocation experts, insurers have **expertise** that can help mitigate the perils presented by extreme heat trends. As investors, we have the **tools and motivation** to help people and property be less susceptible to their effects. Finally, as global citizens, we have the **moral imperative** to partner for collective action to protect and strengthen the communities where we live and work.

To protect vulnerable communities, insurance coverage must become more accessible and affordable. The insurance industry can do its part by applying decades of accumulated pricing and claims data in new ways, using advanced technologies like artificial intelligence (AI) and machine learning (ML) to discern new patterns and reach never-before-seen levels of predictability and accuracy. Further, to support the populations that need help the most, we will have to innovate traditional underwriting approaches, and parametric insurance – where a claim payment is triggered by an event instead of the prolonged process of documenting damages – will play a crucial role.

Further, extreme heat demands a new level of collaboration, with new and different combinations of stakeholders working together. This means insurers working not only with each other but also with regulators, policyholders, local zoning boards, local mayors and community leaders. National adaptation plans are an excellent example of the complementary skills of insurers, public institutions and policy-makers. The basic elements of these plans involve designing available and affordable insurance coverages, tailoring them to be more widely obtainable in heatwave-prone communities and regions, and promoting resilience and risk mitigation efforts that reduce the impact of extreme heat.

This paper will be a valuable resource for anyone interested in learning more about the urgency of extreme heat and what can be done to mitigate its effects. I hope it will serve as a call to action for the global insurance community and willing partners everywhere to shape the world's response.

Executive summary

Addressing extreme heat demands coordinated efforts from insurance, businesses, governments and global organizations.

Extreme heat is one of the most pressing resilience tests for economies and societies. It currently kills approximately 489,000 per year and is projected to cause $2.4 trillion in productivity losses annually by 2030. By 2050, dangerous heat levels will affect at least half the world for at least one month a year. This white paper charts a path for financial institutions, long-term investors and policy-makers to address the causes of extreme heat, develop resilience strategies and fund vital mitigation efforts.

Currently, 88% of weather-related disaster funding is spent on reactive post-event responses. This focus must broaden to make full use of insurance industry strengths and target root causes, such as by achieving net-zero transition goals and advancing innovations like vertical urban farming and artificial intelligence (AI)-enabled parametric coverage. Insurers can increase their societal value by encouraging and rewarding policy-holders who mitigate heat risks and reduce their vulnerability.

This World Economic Forum report provides a roadmap to address extreme heat impacts through proactive long-term solutions and risk reduction strategies. Less than 60% of global weather-related losses are insured, placing a $150 billion financial burden on governments and communities. Insurers must promote greater resilience to make insurance affordable for all communities.

The roadmap for addressing the impacts and causes of extreme heat is a multifaceted framework with specific objectives:

1. **Building a common language around extreme heat**: The scale of the challenge is daunting but needs to be defined, including by quantifying economies' and societies' exposure to rising temperatures. The current risk landscape is assessed in terms of how it has intensified, where impact is most acute and how it will worsen without intervention. It is critical to raise public awareness of what is at risk.

2. **Understanding how climate change is changing the insurance industry**: The causes and impacts of climate change have led life and non-life insurers to support prevention and risk mitigation. With AI, insurance can significantly improve long-range weather and climate predictions, strengthening prevention and enabling new underwriting approaches.

3. **Accelerating adaptation and resilience**: Insurers possess unique capabilities to research, assess and reduce extreme heat risk or provide financial mechanisms for global heat adaptation. Their work involves using enormous amounts of loss information accumulated over decades and investing large amounts of capital in high-impact adaptations and resilience interventions.

4. **Supporting government policies to cultivate a favourable risk-mitigation environment**: Insurance is a highly regulated industry in which companies actively contribute to helping develop, adopt and maintain rules that can be applied to a wide range of socially critical challenges. Climate change is arguably today's most pressing challenge, and extreme heat is at the centre of many life-threatening perils.

5. **Enabling more effective public/private partnerships**: The climate-change risks the world faces today cannot be borne by any one company, industry or government agency. All the actions needed to face the threat of intensifying extreme heat will be more effective when successfully coordinated across all the organizations in the insurance industry in close collaboration and partnership with businesses from other sectors, governments and supranational organizations.

1

Extreme heat risk landscape and the age of global boiling

Extreme heat is a severe climate threat, causing immediate health harm and long-term strain on infrastructure and the economy.

An estimated 489,000 people die annually from extreme heat, making it the deadliest climate risk – killing more people than floods, hurricanes and earthquakes combined.

Earlier in 2024, the planet reached a concerning milestone: each of the last 10 years has ranked as the hottest on record. For the first time, the planet's average temperature over a 12-month period rose 1.5ºC above pre-industrial levels, currently at 1.62ºC and surpassing the limits set by the Paris Climate Accords. As stated by the UN Secretary-General António Guterres, these prolonged periods of extreme temperatures and increasingly frequent and severe heatwaves are moving the world into an "era of global boiling".

Among the many climate risks impacting the world, extreme heat may have the greatest potential to threaten human health, physical infrastructure and economic activity. It has a uniquely far-reaching impact, affecting mental health, educational outcomes, worker productivity, transport networks, utility infrastructure, human migration and political instability.[1]

More than perhaps any other stakeholder group, the insurance industry stands at the forefront of an evolving extreme heat risk landscape. This industry works across various sectors – life, health, property and agriculture – all of which face significant exposure to extreme heat through property damage, crop loss, infrastructure degradation, and significant increases in mortality and morbidity. Additionally, insurers are among the largest asset owners in the economy, and the investment risks tied to extreme heat present severe challenges for the industry moving forward. The Forum's *Business on the Edge: Building Industry Resilience to Climate Hazards* report states that extreme heat causes 72–73% of potential fixed asset losses across industries over the next decade. The business case for investing in climate resilience and adaptation has never been clearer – each dollar invested in climate resilience yields $13 in savings.[2] Despite this compelling business case, 88% of climate disaster financing is still allocated towards post-event response rather than pre-event capacity building.

This fast-evolving risk landscape demands a generation-defining commitment from the insurance industry to address extreme heat.

Insurers can and should play a critical role in addressing extreme heat through their core products and services, playing a leading role in developing sector-specific and localized resilience strategies, and derisking investment and mobilizing capital into high-impact resilience and adaptation interventions.

Growing extreme heat impacts

Between May 2023 and May 2024, 6.3 billion people (roughly four-fifths of the world's population) experienced at least one month of abnormally high temperatures.[3] Those living in prolonged periods of extreme heat are struggling to adapt – poll workers in India, street sweepers in Spain, farm workers in the US and over 1,000 worshippers undertaking the Hajj pilgrimage have all died from extreme heat this year.[4] An estimated 489,000 people die annually from extreme heat, making it the deadliest climate risk – killing more people than floods, hurricanes and earthquakes combined.[5,6] Mass human migration fuelled by extreme heat is already taking place, and the accumulating hazards of climate change could drive food and water shortages, which, in turn, foment political and civil unrest.[7] By 2050, nearly half of the world's population is expected to live through dangerous heat levels for at least one month of the year.[8]

The long-term impacts of rising temperatures on the global financial system will likely be profound. By 2050, extreme heat and related climate risks could reduce the world economy by $23 trillion,[9] with significantly higher losses in the Global South, where nations have fewer resources to adapt their infrastructure and economics. The impacts are even more profound in highly exposed sectors such as agriculture, construction, transport and shipping. In the US alone by 2050, heat-fuelled labour productivity loss is projected to reduce total economic output in construction by 3.5% ($119 billion per year), manufacturing by 1.7% ($90 billion per year) and agriculture by 3.8% ($13.07 billion per year).[10]

FIGURE 1 | **Alarming numbers of extreme heat records were broken in 2024**

Source: National Centers for Environmental Information.

reduction in ship crossings cost global shipping companies roughly $700 million.

Global companies are facing heat-related business disruptions that threaten the delivery of their core products and services. In 2023, drought intensified by extreme heat in the Panama Canal caused water levels to drop, prompting canal authorities to limit traffic. In December of 2023, only 22 ships per day could pass through the canal, down from the usual 38. More than 160 ships were stuck at anchor at both ends. This 36% reduction in ship crossings cost global shipping companies roughly $700 million. Other drought-fuelled shipping disruptions in the Rhine, the Suez Canal and other key waterways have caused significant economic impacts in recent years.[11] Lower water levels also compounded technological and safety risks including the integrity of the energy infrastructure system in Europe, notably causing up to 50% reductions in hydro and nuclear power in certain countries, all at a time when energy supply has been significantly disrupted by the impacts of the Russian invasion of Ukraine.

Higher temperatures are straining physical infrastructure that was designed for a climate that no longer exists. For example, after historic heatwaves in Europe in 2022, record-breaking temperatures in London caused train service delays amid fears of buckling tracks, diverted flights after runways melted and set off dozens of fires, such that the London Fire Brigade saw its busiest week since World War II.[12] In the capital, the cast-iron chains and sculptures of Hammersmith Bridge were wrapped in foil to repel heat after cracks in the iron began to widen, raising fears that the 19th-century bridge could collapse.[13] Europe is warming faster than any other continent, and the race to adapt infrastructure and people to a hotter-for-longer climate is accelerating.

Beyond physical assets, the human health effects of extreme heat can be catastrophic. Extreme heat exacerbates respiratory, pulmonary, kidney and cardiovascular disease, especially for vulnerable populations, including the elderly, children, outdoor workers, homeless people and people with pre-existing conditions.[14] Some of the physical consequences of heat, such as heat stroke and

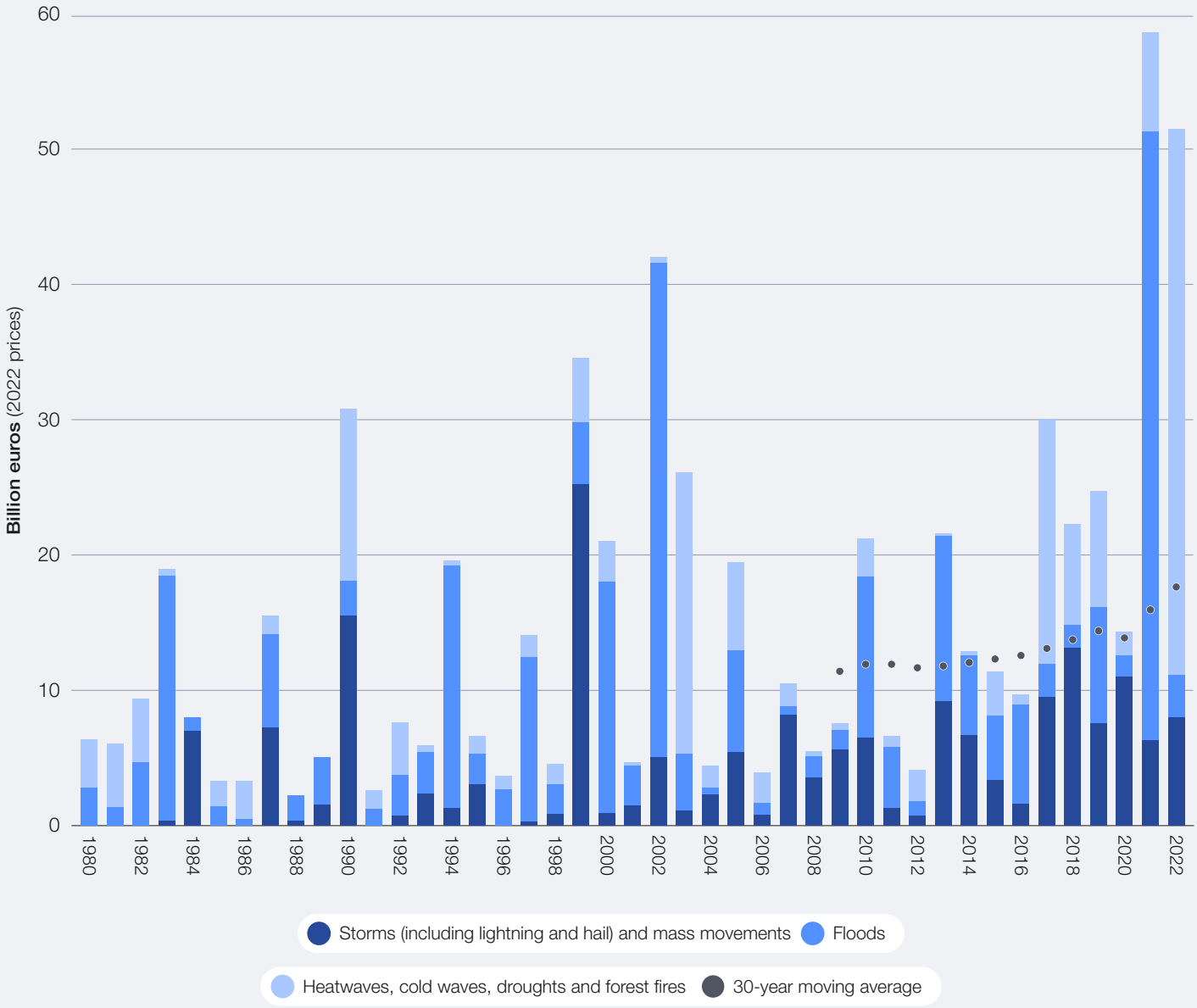
> Heat stress can lead to exhaustion, heatstroke and, in the long term, serious and debilitating chronic conditions such as cardiovascular disease and respiratory illness.

heat exhaustion, are well known, but the significant mental health and psychological consequences are less widely recognized. In some cases, extreme heat can lead to depression, panic attacks and even suicide.[15] Concomitant trends, such as population growth, ageing and urbanization, further exacerbate the impact of extreme heat on human health.[16]

In communities most vulnerable to global warming – particularly those in tropical regions and in cities – rising temperatures are pushing people to the limit of human survival. This phenomenon is known as a "wet bulb temperature", a measure of heat that considers air temperature, humidity, wind speed, cloud cover and other key variables to more accurately gauge physiological stress caused by extreme heat. When wet bulb temperature is reached, the body can no longer release heat through sweat evaporation, which can lead to heat stress, organ failure or even death. These dangerous temperature levels are likely to be reached more regularly in the coming decades.[17]

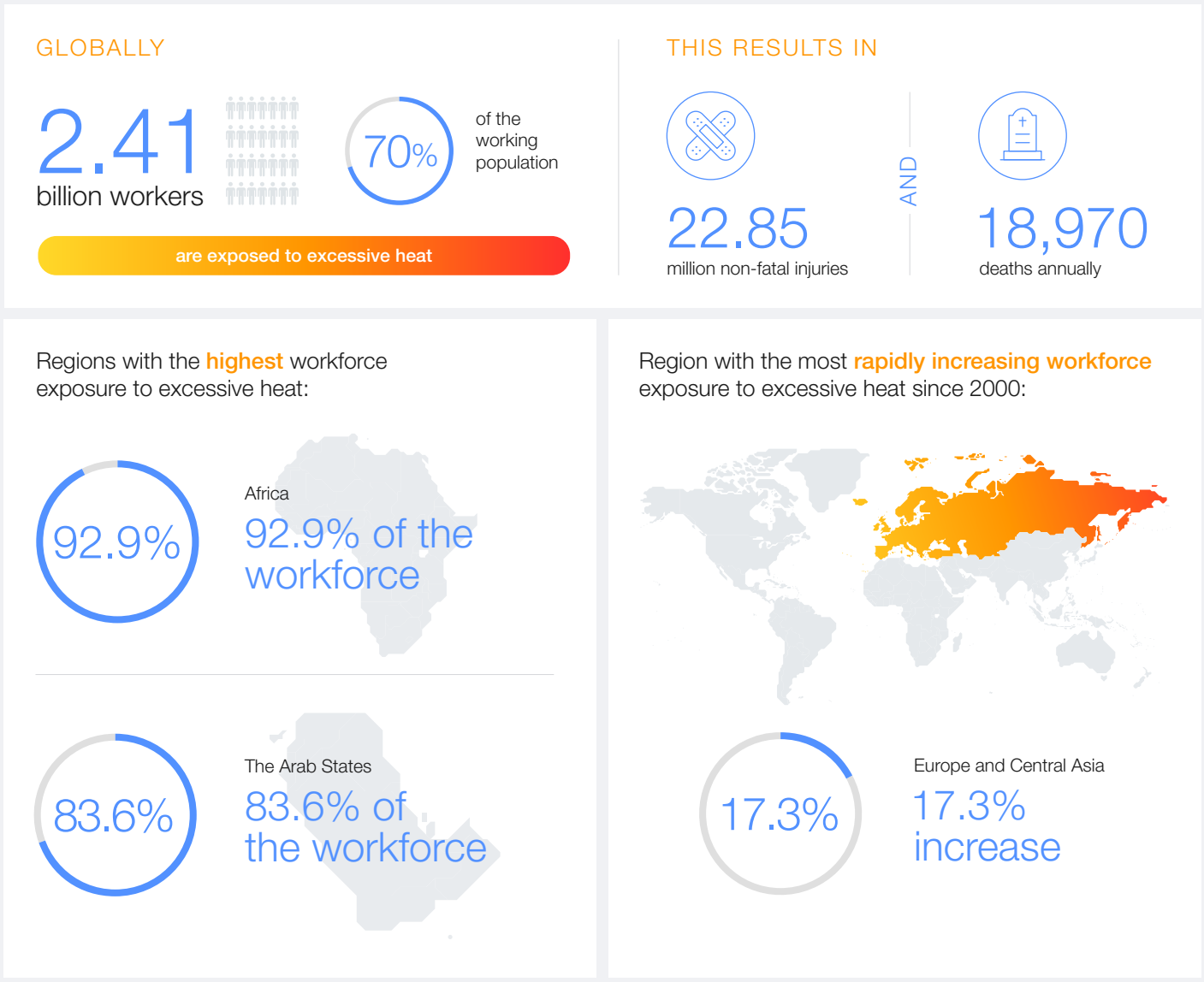
Today, 2.4 billion workers (representing 70% of a global workforce of 3.4 billion) are exposed to excessive heat while on the job.[18] Again, these impacts are not distributed evenly across the world – in Africa, 93% of workers are exposed to extreme heat, and in the Arabian Peninsula, over 83% of workers are exposed, while in North America, that number is only around 10%.[19] Heat stress can lead to exhaustion, heatstroke and, in the long term, serious and debilitating chronic conditions such as cardiovascular disease and respiratory illness. The International Labour Organization (ILO) indicates that 25.6 million people are currently living with chronic kidney disease as a result of heat stress in the workplace.[20]

FIGURE 2 **Economic impacts from heat-fuelled perils have increased drastically in recent years**



Source: CarbonBrief. (2022). *Mapped: How climate change affects extreme weather around the world*. https://www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world/.

FIGURE 3 | **Vulnerable workers are at the front lines of the extreme heat risk landscape**



Source: International Labour Organization (ILO).

Worker health and the associated labour productivity loss are among the most critical drivers of economic impacts from extreme heat. A 2021 study identified that in the US alone, more than 2.5 billion hours of labour were lost due to heat in the agriculture, construction and manufacturing sectors. This cost the economy about $100 billion, a figure projected to grow to $500 billion per year by 2050, with disproportionate impacts in economies in the Global South.[21] By 2050, heat stress is projected to fuel 2.2% loss in total working hours, representing economic losses of $7.1 trillion due to loss in labour productivity.[22] Employers, business leaders and policy-makers are actively developing strategies to protect worker health and productivity amid more prolonged periods of extreme heat.

While extreme heat is beginning to rise to the top of the industry agenda, it still receives less attention than more visible and immediate climate risks such as hurricanes and floods. Extreme heat – often referred to as the "silent killer" – has uniquely diffuse and long-term impacts, which present a particularly complex challenge for the insurance industry and for economies and societies more broadly. The effects of heat can take days to escalate and are addressed through an extensive set of short- and long-term mitigation measures. Individuals will also be affected by extreme heat differently depending on age, gender and medical history, making it difficult for insurers to define universal triggers to inform their policies.

Despite these challenges, today's risk landscape presents opportunities for business leaders to proactively build climate resilience into business models, products, workforces and investments. As extreme weather events such as heatwaves and wildfires become more frequent and intense, companies and governments are creating innovative mechanisms for financing and transferring risk in non-traditional ways.

2

The uninsurable world and the insurance protection gap

Insurers are facing rising exposure to extreme heat, amplifying related climate risks, straining affordability and availability of insurance, and leading to long-term consequences for vulnerable communities.

Extreme weather events are occurring more frequently with greater intensity and unpredictability, disrupting climate models and challenging risk management strategies for insurers worldwide. Insurance companies are finding that the historical weather patterns that once informed risk models are less reliable in today's climate risk landscape, leaving industry leaders less certain about how to price policies effectively.[23]

2024 is projected to mark the fifth consecutive year that the global insurance sector faced over $100 billion in net underwriting losses.[24] This means that the insurance industry has paid out an average of $100 billion more in claims than they receive in contributions from policyholders. This loss ratio is entirely unsustainable in the long run.

Insurance companies are responding to these climate-driven financial risks by reducing coverage in exposed markets, raising premiums and, in some cases, exiting risk-prone communities altogether.[25] At the same time, as insurance rates increase, people forgo coverage – this not only leaves them vulnerable to climate risks but also drives prices even higher as the number of people paying premiums and sharing risks shrinks. This perfect storm makes it more difficult for people in these vulnerable communities to access insurance. It fuels several secondary impacts: preventing individuals from accessing a mortgage, fuelling climate migration, and dragging on macroeconomic stability and growth.

Affordability of insurance requires a paradigm shift in the way society manages extreme weather risks across the life cycle of homes, focusing on reducing exposure and vulnerability. An all-of-society approach is key, empowered by decision-relevant risk information. For example local governments can update zoning and enforce new building codes, utilities can invest in strengthening resilience of critical infrastructure, communities can preserve nature-based ecosystems and homeowners can invest in retrofits or make smart buying choices. National governments could not only invest in risk reduction measures, but also incentivize and encourage insurance uptake over reliance on post-disaster aid.

Maryam Golnaraghi, Director, Climate Change and Environment, The Geneva Association

CASE STUDY 1

Wildfire risk is upending the insurance industry

The State of California is a useful case study in understanding the implications of increasingly frequent and severe climate perils on the attainability and affordability of insurance.

A warmer and drier climate is compounding wildfire risk in California. Since the 1980s, wildfire season has extended by 27% globally,[26] particularly increasing in the Amazon, Mediterranean and the western forests of North America – notably California. With new research showing that the world could reach 2.7ºC of warming by the end of this century, climate change is leading to larger and more frequent wildfires in much of the world.[27] In 2024 alone, over 6,500 fires have burnt over 1 million acres of land in California.

The insurance industry is struggling to respond to this heightened risk landscape. The 12 largest homeowners insurance providers in California account for 85% of the market. Of these 12:[28]

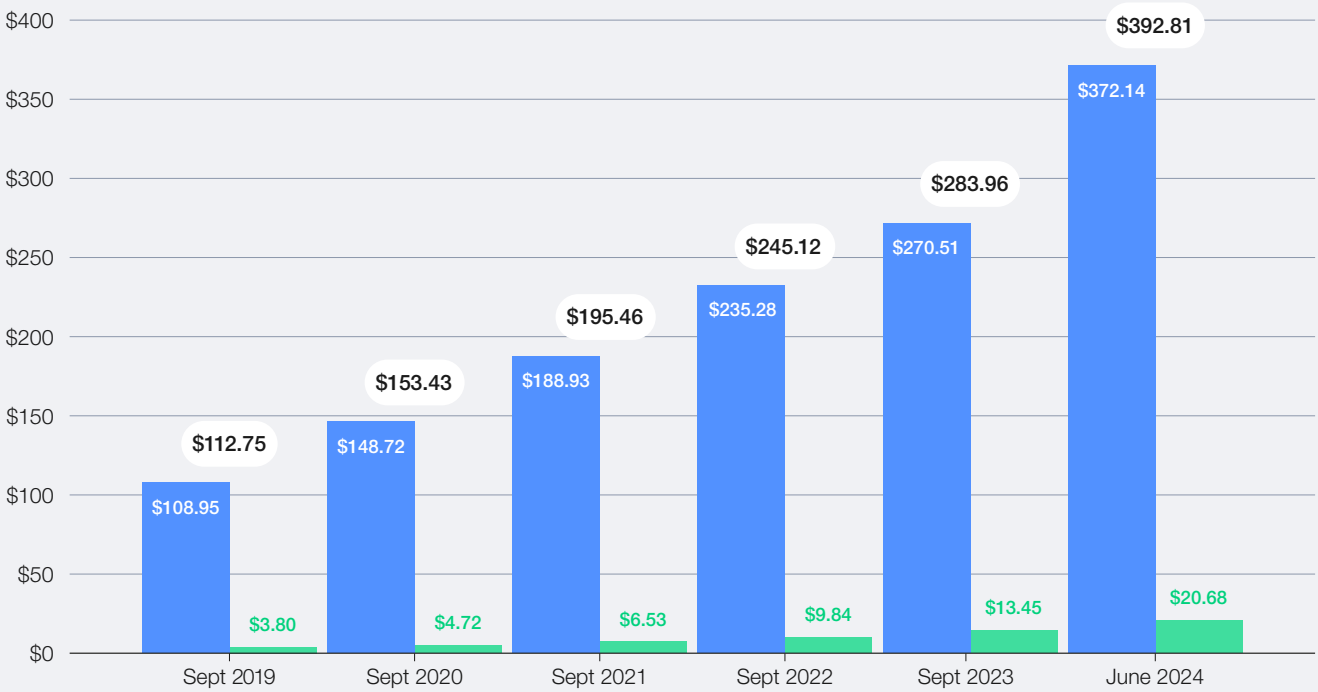
- Seven have limited new customers from acquiring homeowners insurance from their respective companies.
- Six have announced intentions to discontinue portions of their existing policies. For example, one insurer has already executed 8,000 non-renewals for current customers. As a result, long-time customers who have relied on their insurers to protect their homes will no longer have access to the coverage they once depended on.[29]

These companies cite growing exposure to catastrophic events, unprecedented increases in construction costs that exceed inflation, and a challenging regulatory environment that inhibits insurers from accurately pricing risk. The insurance industry's recent losses in California's wildfire market are telling – during the 2017-2018 fire season, insurers in the state lost the equivalent of two decades' worth of profits.[30] As a result, large parts of California are at risk of becoming "insurance deserts", further worsening the state's housing crisis by making it difficult for homeowners to secure mortgages. This, in turn, stalls new construction and threatens the long-term economic stability of high-risk communities.

As climate damages increase and private insurance companies reduce coverage, homeowners are flocking to the government-run insurance programme known as the FAIR Plan, which provides basic property coverage to homeowners and businesses. The FAIR Plan, created to be California's insurance plan "of last resort", has increased to 3% of California's market, equalling the state's 10th largest insurer. The FAIR Plan's growth does not appear to be sustainable. In the next three years, $5 trillion in coverage is projected to sit on the balance sheets of government-run insurance plans in California and Florida alone. This increases the likelihood that these schemes will require bailouts from Congress, leaving the American public on the hook. The Fair Plan also uses industry assessments to shift losses onto policyholders in private insurance markets, further driving up rates and impacting affordability.

The fair plan faces increased exposure

As of June 2024, the FAIR Plan's total exposure is **$393 billion**, reflecting a **38.3% increase** since September 2023 (fiscal year-end) ($ billion).



Source: California Fair Plan. (n.d.). *Key Statistics & Data*. https://www.cfpnet.com/key-statistics-data/.

Turmoil in insurance markets not only impacts housing but also may portend a stormy picture for the economy as a whole. In the US, much of the banking sector is built on housing and property. Without insurance, banks will not issue mortgages; without mortgages, people cannot buy homes. This further strains an already tight housing market in the state, and causes decreasing property tax revenues, which, in turn, leaves communities with less revenue for schools, police and other essential services. Communities that are "uninsurable" are also "uninvestable", which spurs long-term economic and social consequences for climate-risk-prone communities. Additionally, smaller regional banks are often more vulnerable to disruptions in the commercial and residential real estate markets, further straining institutions that have already exhibited susceptibility to instability and failure.

In the long term, building climate resilience in California will require a generation-defining commitment from the private sector, policy-makers and other key stakeholders. This will involve retrofitting infrastructure and human capital to thrive in a world more prone to climate risks.

In the short term, much of the insurance industry is proposing policy and regulatory changes to keep insurance affordable and attainable in climate-risk-prone communities, including:

- **Reinsurance priced into rates**: insurance companies buy reinsurance to cover the costs of claims, and these reinsurance rates are also rising. Discussions are under way to factor in the net cost of reinsurance as a legitimate business expense when setting rates. This will help improve access to coverage and is already considered in rates across all states except California.

- **Predictive risk modelling**: Californian regulators have made significant progress in building a system that allows forward-looking, science-based risk modelling to predict the likelihood of catastrophic events. As the severity and frequency of these events increase, relying on 20 years of past claims data to determine rates is no longer effective in assessing current risk. Catastrophic risk modelling is used in almost every other state.

- **Rate process**: Californian regulators continue to work towards a streamlined rate application review process. Currently, California's rate filings can take over six months to review and up to a year or more when an intervenor is involved. California is one of the only states that allows external groups to participate in the rate review process.[31]

Keeping California insurable aligns with the incentives of communities, insurance companies and policy-makers. The question of how to keep private insurance attainable and affordable in the state is a challenge, especially in light of the increasingly unsustainable growth of California's public insurance market. The insurance industry and policy-makers must balance making insurance affordable and accessible for homeowners with allowing insurers to set prices that reflect increasing climate-related risks.

Despite the challenges, there have already been promising developments on this front:

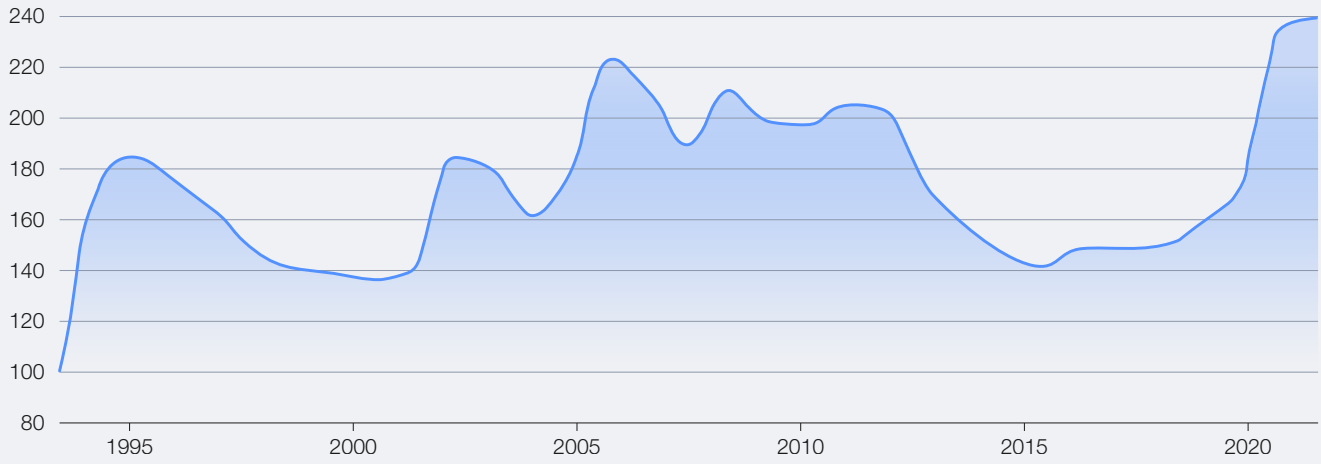
- **Regional resilience grants**: These fund regional partnerships, allowing them to plan and implement climate adaptation and resilience projects.[32]

- **Climate-related financial risk act**: The California Senate Bill 219 requires companies with annual revenues of at least $500 million to prepare reports on climate-related financial risks.[33] The first reports are due by 1 January 2026.

- **Risk communication:** Sharing risk information with decision makers can help create risk-based pricing signals that encourage sustainable development, risk reduction, and rebuilding efforts.

- **Hazard maps**: These maps help identify communities at disproportionate risk from climate perils and highlight opportunities to promote available insurance solutions.[34]

The cost of reinsuring properties against extreme weather has increased



Note: Index of property catastrophe reinsurance rates (rebased, 1992=100). **Source:** Howden.

> About 58% of economic loss from natural disasters is insured in North America, compared to 29% in South Africa and only 9% in India.

The global picture and the insurance protection gap

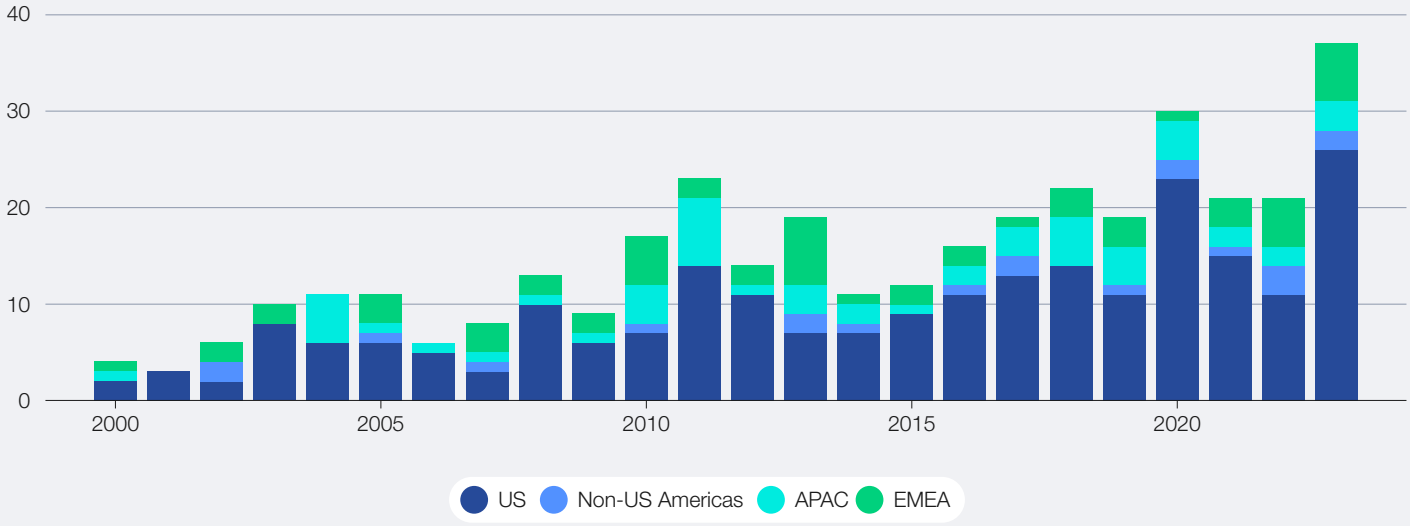
Extreme heat and related climate perils are not limited to California – a warmer and drier climate is already compounding the risk of wildfires globally across a wide range of ecosystems. Indirect effects, including post-event air quality degradation, are disrupting workers and dragging on economic growth. Millions of homeowners worldwide are on the front line of an insurance affordability crisis. Insurance deserts are forming and expanding across Australia,[35] Asia[36] and elsewhere.

As insurance deserts expand, more homeowners and communities are left without coverage amid heightened climate risk. In 2023, only 38% ($108 billion) of global economic losses were insured. This ratio is at risk of becoming more unbalanced as insurance companies struggle to stay active in climate-risk-prone communities.

The gap between insured and uninsured losses points to the global "insurance protection gap" – a measure of people and communities without access to insurance. The insurance protection gap is a key indicator of economic and societal resilience to climate perils, as a wide protection gap lowers the financial ability of economies to recover from disasters. The insurance protection gap varies widely by geography. For example, about 58% of economic loss from natural disasters is insured in North America, compared to 29% in South Africa and only 9% in India.[37] In 2023, the global insurance protection gap was estimated at 74.3%, indicating that three-quarters of climate-related disasters – amounting to approximately $385 billion in damages – were not protected by insurance. Furthermore, the little progress that has been made is heavily weighted towards upper- and middle-income countries, whereas the insurance protection gap has persisted in lower-income countries.[38]

Closing the protection gap will build and accelerate resilience, empower vulnerable communities to thrive amid climate risks, incentivize less risky behaviour and ultimately save lives. It will also allow the industry to enter untapped markets and ignite economic growth to even beyond pre-disaster levels.

FIGURE 4 **2023 had a record number of billion-dollar insured losses from extreme weather**



Note: APAC = Asia and the Pacific; EMEA = Europe, the Middle East and Africa. **Source:** Aon.

TABLE 1 **The insurance protection gap in recent climate events in India**

Year	Natural disaster	Economic loss	Insured loss	Insurance gap
2020	Cyclone Amphan	$13 billion	$1.5 billion	$11.5 billion
2021	Cyclone Yaas	$2.5 billion	$200 million	$2.3 billion
2021	Tamil Nadu floods	$1 billion	$100 million	$900 million
2022	Assam floods	$3 billion	$300 million	$2.7 billion
2023	Himachal Pradesh floods and landslides	$1.5 billion	$150 million	$1.35 billion

Source: Bajaj Allianz General Insurance using data from SwissRe and Aon.

3 Innovative insurance products and partnerships

The insurance industry is driving innovative products and partnerships to address the impact of extreme heat and related climate perils.

Addressing the impacts of extreme heat and related climate perils will require a multistakeholder approach, in which the insurance industry must play a central role. Insurance is the most tangible form of climate adaptation that individuals and communities can access. The insurance industry's response to extreme heat involves using past products and partnerships that have been successful in addressing other climate perils – especially flood insurance. However, the unique challenges posed by extreme heat require the insurance industry to take on a reimagined role as risk advisers, data consultants, influencers and de-riskers of investment while also helping to develop resilience strategies that engage policy-makers, regulators, business leaders and other key stakeholders at local, national and global levels. While the industry can do more to address the climate crisis, industry leaders are already advancing innovative products and partnerships to address extreme heat.

3.1 Parametric insurance

Parametric insurance has emerged as one of the most promising mechanisms for enhancing climate resilience in recent years. Also known as event-based or index-based insurance, this product provides payouts when specific trigger conditions are met. The use of predefined triggers and measurable indexes offers greater transparency, speeds up the claims process, reduces administrative and frictional costs, and strengthens resilience for vulnerable communities.[39]

Parametric insurance is linked to the loss-causing event rather than the actual loss sustained from the natural disaster, meaning it can increase the scope of coverage and protect against the losses that traditional insurance cannot (or will not underwrite).[40] Parametric insurance products use weather data readily available to the public, such as rainfall, wind speed or temperature, which reduces the information asymmetry between policyholders and insurers when a climate disaster strikes.

As climate risks become increasingly frequent, intense and long-lasting, parametric products can play a crucial in mitigating both direct and indirect losses.

Parametric tools have been used across a host of climate risks, such as coral reef repair and protection during hurricanes, reforestation after wildfires and mitigating the impacts of crop loss during a sustained drought. This can help mitigate economic losses associated with business disruptions across agriculture, infrastructure and other highly exposed sectors. Parametric insurance has gained traction amid difficult underwriting conditions and protection gaps – as these products evolve, they are broadening the scope of coverage to events such as extreme heat. In 2023, The Atlantic Council Climate Resilience Centre, the Self Employed Womens Association (SEWA) and Blue Marble developed the Extreme Heat Protection Initiative, an integrated approach that combines risk transfer, risk reduction and financial inclusion.

CASE STUDY 2

Women's Climate Shock Insurance and Livelihood programme

In 2024, a first-of-its-kind solution – the Women's Climate Shock Insurance and Livelihood programme, supported by Climate Resilience for All, SEWA and SwissRe – combined heat parametric insurance and direct cash assistance for 46,000 informal female workers facing life-threatening working conditions due to extreme heat. Triggered by specific high temperatures in three states in India, the programme included a heat early warning system and promoted financial inclusion by requiring participants to open bank accounts. This innovative framework is expanding to new geographies and exploring additional heat-mitigation solutions like cooling stations, shared water tanks and shaded workspaces.

We are proud to have partnered with Climate Resilience for All in delivering an innovative parametric earnings protection solution that has benefited over 46,000 women. We welcome global discussions to better mitigate against and adapt to extreme heat and where we can offer our expertise in risk modelling and bespoke, pre-arranged financing mechanisms for fast response.

Veronica Scotti, Chairperson, Public Sector Solutions, Swiss Re

CASE STUDY 3

Extreme heat parametric insurance for exposed workers in Hong Kong

Climatological data over the past three decades paints a discernible picture – the annual mean temperature in Hong Kong has exhibited a statistical increase of 0.30°C per decade from 1994 to 2023. In response, AXA Hong Kong and Macau launched the 'Heatwave Parametric Insurance', the region's first insurance product tailored for outdoor workers exposed to extreme summer heat. With a premium of HKD 19.9 (Hong Kong dollars) per person, it offers a payout of HKD 100 or an anti-heatwave kit when temperatures exceed 36.0°C for three consecutive days between August and October.[41]

CASE STUDY 4

Regional risk pooling in Africa

Founded in 2014, Africa Risk Capacity (ARC) is a hybrid mutual insurer that provides parametric insurance services to 33 African Union member states and farmer organizations. ARC uses innovative financing mechanisms and risk-sharing arrangements to address climate risks in Africa. Its multijurisdictional approach enables member states to share climate-related risks, reducing the burden of natural disasters on individual governments and populations. For instance, a parametric product indexed to rainfall triggers payouts approximately four weeks after a harvest to mitigate the impact of drought-induced crop loss. Additionally, participating governments must submit contingency plans, making ARC's parametric insurance a valuable capacity-building tool for policyholders, enhancing disaster preparedness.

CASE STUDY 5

Coffee farmer parametric insurance in Indonesia

Blue Marble, an innovative insuretech provider, partnered with Nestlé to launch a parametric insurance product that financially protects smallholder coffee farmers in Indonesia from increasingly volatile weather conditions such as drought and excessive rainfall. This product uses satellite-based climate data to monitor disruptions in coffee production, with automatic payouts issued to registered farmers impacted by these climate events. Through this protection, vulnerable coffee farmers gain access to critical insurance coverage, helping them build resilience and adapt to climate risks. This project is one of many examples where Blue Marble has developed tailored parametric insurance solutions to address specific needs across various markets and commodity value chains.

CASE STUDY 6

HazeShield

Pioneered by Swiss Re, this parametric insurance solution was designed to protect Singaporean businesses facing financial disruption due to severe haze caused by wildfires in Indonesia. HazeShield uses a haze pollutant index and private and government data to create a parametric policy with incremental payouts based on fire activity, weather patterns and number of days of health-threatening particle pollution. This product can provide invaluable protection against business interruption for losses stemming from reduced productivity, suspended operations for outdoor workers, event cancellation and slowdowns in tourism. If applied to heat-related risks, this product model is a useful precedent for further parametric innovation.

Though parametric insurance presents many benefits, it has limits. By covering only specific thresholds or trigger events, it leaves out damages that fall outside the defined parameters, exposing policyholders to economic impacts below the trigger level. For instance, a parametric policy for crop loss due to drought may be designed to pay out if cumulative rainfall during the risk period (May to July) falls below 50 mm. However, if an agricultural business or cooperative experiences significant disruptions with 55 mm of rainfall, they would not receive any compensation, as the pre-defined threshold was not met. Parametric products may also risk becoming financially unsustainable as rising climate risks could lead to more frequent payouts.[42] Finally, there remains a lack of awareness of the potential benefits of parametric solutions. Business leaders would benefit from greater education on topics such as parametric indices, the definition of triggers and forecasts used in underwriting, and the connection between these products and the economic impacts of extreme weather events. Despite limitations, parametric products will continue to play a role in addressing extreme heat and building climate resilience in vulnerable communities going forward.

3.2 New tech for risk insights

Insurers are increasingly using new technologies for risk management and climate resilience. Artificial intelligence (AI) for extreme weather event prediction, geospatial data for hazard mapping and machine learning for strengthening risk models are all allowing the industry to predict and mitigate climate disasters more effectively.

Traditional climate risk evaluation methods face significant challenges in the face of evolving climate threats. For example, wildfire risk modelling may not fully capture the complex interactions between increasingly frequent and intense wildfire risk drivers – such as extreme heat – and the escalating intensity of extreme fire behaviour.[43]

Complex perils, such as wildfires and floods, rely heavily on simulating intricate, fine-scale physical interactions, which poses challenges for traditional models. Modern probabilistic models stand to benefit from emerging technologies that can capture subtle, hard-to-detect relationships essential

> Improved climate risk data enables the development of forward-looking risk models, reducing reliance on outdated historical data.

for accurately reflecting real-world dynamics. Although it's still uncertain exactly how much these advancements will improve extreme heat risk modelling, they appear valuable for enhancing predictive capabilities and resilience planning.

Advances in technology and richer data sets are enabling insurers to develop more sophisticated climate risk models, improving their understanding of exposures and enhancing their ability to effectively underwrite climate risks. Improved climate risk data enables the development of forward-looking risk models, reducing reliance on outdated historical data. Analysing yesterday's data is ineffective in today's fast-changing climate risk landscape.

The insurance industry is making increasing use of machine learning tools to comb through large weather datasets and identify complex climate system relationships. It can use these tools to strengthen insurance company perpetration, alerting and response to weather events in ways that can encourage loss mitigation and reduce business interruption. One example is Sentrisk – an AI-powered platform that allows companies to proactively apply climate risk data to minimize business interruption, optimize risk transfer and reroute supply chains in the event of a natural disaster.[44] This tool overlays risk data for geopolitical and natural hazard risks and allows users to see live alerts on disruptions.

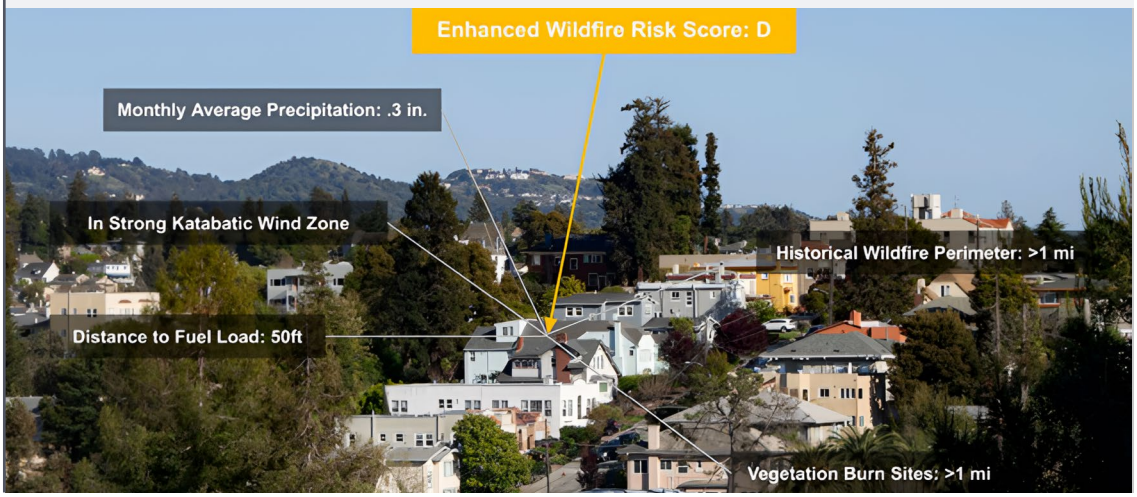
Developments in sensors and wearables will also be vital for the insurance industry to address the impact of extreme heat. These devices can help carriers collect real-time data to assess, mitigate and assess, mitigate and price, according to heat-related risk.[45] These devices are being successfully piloted for exposed workers in high-risk sectors, including construction, agriculture and trucking.[46] This is particularly important for the life insurance industry, but in the future, this concept could also apply to physical assets. There are ongoing efforts to develop data infrastructure that provides real-time monitoring of heat stress on physical assets such as roads, bridges, train tracks and other vital infrastructure exposed to heat stress.

While improved risk knowledge is critical for understanding and addressing climate risks, it can sometimes lead to unintended consequences. For example, an insurer's enhanced understanding of climate hazard exposure may result in certain areas being deemed too high-risk to insure, creating challenges for communities and homeowners in accessing coverage. However, market-risk based pricing signals are critical for incentivizing more sustainable and resilient land use planning, building codes and development strategies in the long run.[47]

CASE STUDY 7

Enhancing household resilience with innovative data solutions

Property-level precision data empower insurers, homeowners and communities to adapt to climate risks. For example, Guidewire's HazardHub uses geospatial data, AI, machine learning and aerial imagery to generate resilience scores, considering factors such as wildfire risk, fire protection, wind exposure, proximity to fire stations and hydrants, and property details like building size and construction type. Guidewire's analysis of 91,800 home inspections in California reveals that of the homes that implemented all 13 key mitigation measures – such as home hardening, zoning reforms, wildfire-informed development and external buffers – only 26% sustained any damage during a wildfire. However, while individual home hardening plays a crucial role, significant risk reduction, particularly for conflagration risks, requires neighbourhood- or community-wide adaptation measures. Enhanced risk assessment allows insurers to collaborate more effectively with homeowners, businesses and communities to mitigate risks in high-hazard areas. This helps narrow the protection gap, attracts more risk capital to the market and bolsters community resilience.



3.3 Early warning systems

Early warning systems for extreme weather events save lives and will be a key tool to manage the impact of extreme heat in the future. Early warning systems have helped reduce the number of people killed by natural disasters by 76% since the 1970s.[48] However, as with many of the effective solutions for climate change, early warning systems are not equally available across climate-risk-prone communities and economies.

Insurers can use their superior climate risk data collection to help strengthen early warning systems and proactively identify potential threats and trigger alerts. Climate risk data derived from early warning systems allows government, insurers and policy-makers to take pre-emptive action, such as sending out alerts to policyholders and informing disaster response teams.

Early warning systems and parametric insurance products can work together effectively for disaster risk management. Early warning systems gather data from weather stations and satellites, while parametric insurance provides immediate payouts based on predefined triggers. For example, low rainfall levels provide early warning of an impending drought and parametric products can offer coverage for losses that are difficult to model. ARC uses Africa RiskView – a satellite-based system – to monitor weather patterns and trigger payouts when a parametric index is exceeded.[49] In the UK, the Heat Health Service issues forecasts for high temperatures and a tiered alert system with five levels, ranging from level 0, which focuses on long-term planning, to level 4, indicating an emergency response. Depending on the alert level, this system mobilizes public health resources and emergency responders, and provides guidance for business leaders to protect workers amid hazardous heat conditions.

France took perhaps the most proactive response in Europe after a 2003 heatwave killed 15,000 citizens in a fortnight, establishing the Vigilance heat and health early warning system with a tiered alert structure to protect vulnerable residents from heatwaves.

Investments in early warning systems have been recognized as a key priority for national adaptation programmes. The United Nations estimates that over the next five years, $3.1 billion will be necessary to strengthen early warning systems, particularly in the Global South. This will strengthen disaster risk knowledge and management while bolstering observation in forecasting and communications infrastructure and enhance preparedness and response capabilities.[50] A recent study from the World Meteorological Organization projected that scaling up heat health warning systems in 57 countries alone would save almost 100,000 lives per year.[51]

> The United Nations estimates that over the next five years, $3.1 billion will be necessary to strengthen early warning systems, particularly in the Global South.

3.4 Heat action plans

As communities unaccustomed to extreme heat face consistently higher-for-longer temperatures, communities, cities and nations are creating heat action plans. A heat action plan is designed to mitigate the social, economic and health impact of extreme heatwaves. This typically includes a set of coordinated actions to be taken by various organizations, including public health departments, emergency management agencies and community groups. It also involves a local heat vulnerability index with multiple trigger points at different daytime and overnight temperatures, as well as the duration of multi-day extreme heat events Based on these pre-defined triggers, communities roll out key services (primarily aimed at vulnerable residents), including cooling centre activation, community outreach and emergency response protocols. Successful heat action plans typically bring together stakeholders working in isolation, especially from areas such as infrastructure and the built environment, insurance, public health, workforce safety, emergency planning and response, and data.[52]

Sydney's Heat Action Plan for 2025-2030 aims to ensure people living in Greater Sydney can survive and thrive in a warming climate and during acute extreme heat events. The Greater Sydney Heat Taskforce convened key organizations across health, urban planning and design, infrastructure, emergency management, and the private sector to collaboratively design the plan, which is guided by six key directions to enhance extreme heat resilience:

1. **Heat-smart decisions**: Collaboration, shared understanding and monitoring of heat risk improves heat risk decision-making for Greater Sydney.
2. **Heat-smart places for people**: Homes and buildings are heat-responsive and can keep people safe from heat, while heat mitigation and adaptation are required in state and local planning controls.
3. **Heat-smart economies**: The private sector plans for heat, supports risk reduction, minimizes the economic impacts of heat and seeks commercial opportunities in adaptation.

4. **Heat-smart infrastructure**: Interconnected, resilient infrastructure enables communities to survive and thrive.

5. **Heatwave ready**: Clear governance arrangements, funding and guidance support effective heatwave management, while communities and organizations are empowered to build resilience, reduce risks and manage emergencies.

6. **Heat-smart research**: Researchers and practitioners work collaboratively to deliver heat-resilient solutions.

CASE STUDY 8

Heat action plans are building community resilience in India

India was the first South Asian country to create a heat action plan after an extreme heatwave in Ahmedabad in 2010 resulted in a 43% increase in mortality.[54] The plan includes a system to alert residents when dangerous heatwaves are expected and provide cooling centres. It also educates healthcare workers about how to recognize and treat heat-related illnesses. A study of the impact of this programme has shown it saves around 1,190 lives per year.[55]

This heat action plan was complemented by a statewide policy to paint or tile roofs in white to reflect sunlight and help cool buildings.[56] Heatstroke wards were also set up in the state's major hospitals,[57] while a workshop run by India's National Disaster Management Authority helped local officials prepare for extreme heat.[58] To develop effective heat action plans, insurers worked more closely with policy-makers and government officials. Together, they used the industry's leading risk analytics, predictive tools and climate data to inform more heat action plans and direct capital towards high-impact adaptation interventions.

Other aspects of heat action plans that have proven successful in other cities around the world include worker protection during heatwaves (longer breaks during peak heat hours and mandated air-conditioned rest areas with water provided), communication campaigns for vulnerable individuals, naming and ranking heatwaves, and the appointment of a chief heat officer.

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Extreme heat is accelerating, with far-reaching impacts on workers, communities, and economies. With essential heat knowledge and solutions, every industry can protect the health and safety of workers, minimize productivity losses, and ensure the resilience of supply chains and critical infrastructure. By addressing these risks, businesses can safeguard their operations and the communities they rely on, building stability and resilience in an increasingly hot world

Kathy Baughman McLeod, Chief Executive Officer, Climate Resilience for All

3.5 Nature-based solutions

A growing body of scientific and economic research has been directed to assessing the efficacy of nature-based solutions (NBS) to address extreme heat.

A collection of infrastructure investments – including tree canopies, cool and green roofs, and cool surfaces – can significantly reduce ambient temperatures, complementing more immediate response efforts such as public cooling centres and mass communication efforts. According to a 2022 Kaiser Permenante research article, researchers are increasingly able to measure these interventions' temperature, public health and economic benefits, particularly for vulnerable populations exposed to extreme heat.[59]

World Economic Forum research shows that NBS for climate resilience are 50% more cost-effective than traditional grey infrastructure. NBS also provide 28% more added value by boosting productivity and delivering positive outcomes like reducing emissions from buildings, enhancing climate resilience, capturing land value and creating jobs.[60] Furthermore, NBS play a crucial role in addressing biodiversity loss, restoring natural habitats and building community resilience by improving the health and socioeconomic conditions of climate-risk-prone communities. Despite these proven benefits, NBS receive less than 0.3% of current urban infrastructure funding.[61]

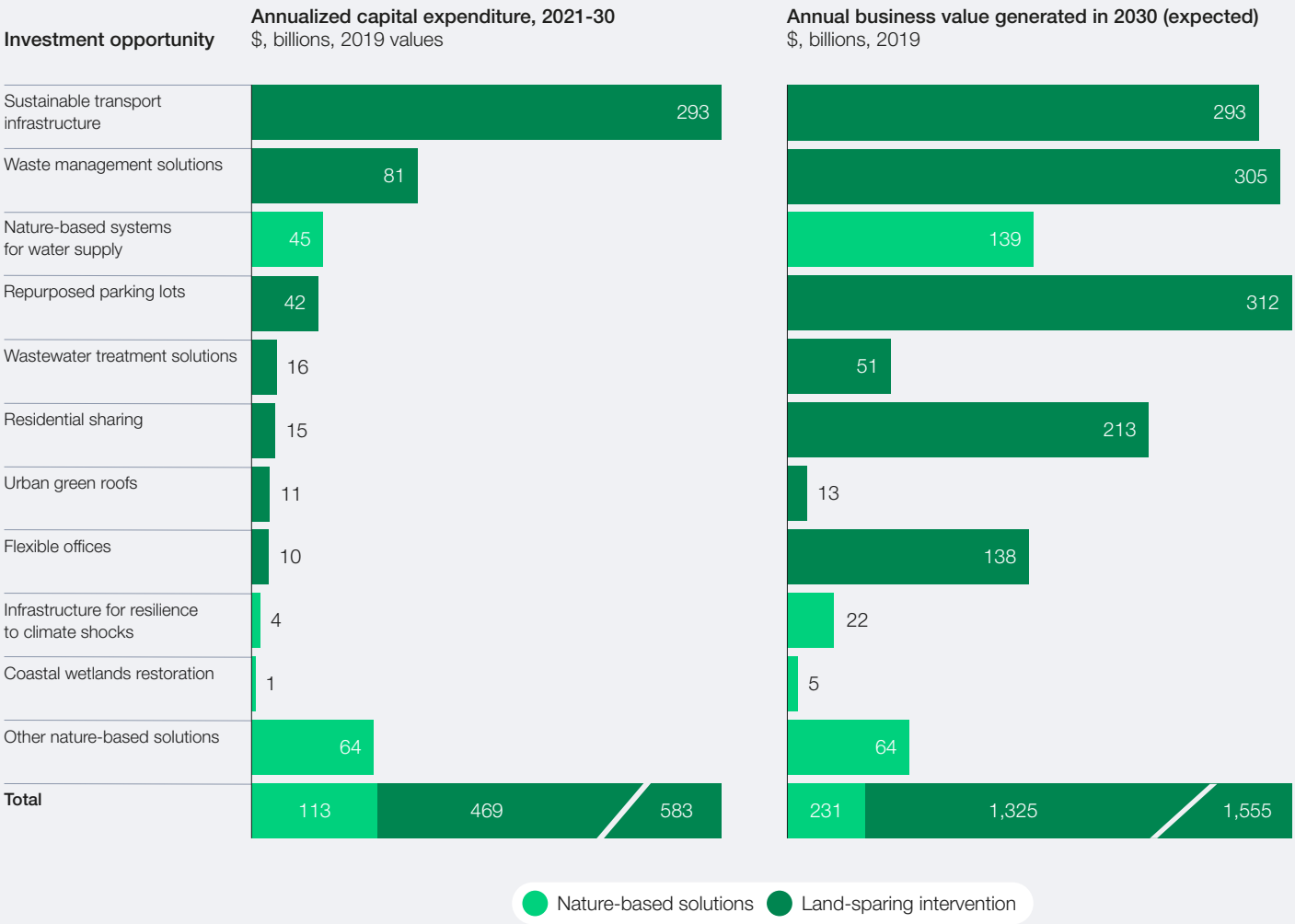
NBS are particularly impactful in cities, which are currently home to half the world's population, and will host an additional 2.5 billion people by 2050 and are projected to experience double the intensity of heat stress compared to rural surroundings.[62] A recent study from The Nature Conservancy institutes a roadmap for using NBS (particularly targeted tree plantings) in 61 of the world's largest cities to increase urban tree cover from the current 1.5-3% to 7%.[63] This change would meaningfully decrease temperatures and save lives.

Insurance companies can help accelerate NBS, especially in cities where the urban heat island effect can raise temperatures by as much as 7°F due to heat-absorbing surfaces, heat-generating activities, and limited vegetation.[64] Public utilities and grid providers would greatly benefit from reductions in energy demand during heat events. Insurers can work with investors, policy-makers and city planners to identify bankable NBS projects, de-risk investment in critical adaptation and resilience interventions, and work with government to provide vital coverage for these projects.

NBS not only helps mitigate the climate impacts of extreme heat, but also addresses the interconnected environmental challenges, including declining soil health, increasing water scarcity and deteriorating water quality. These environmental challenges, often driven by land use changes, weaken the resilience of communities and economies. NBS are particularly impactful in vulnerable, low-income urban communities that disproportionately suffer from extreme heat. These solutions can benefit such communities by reducing temperatures, improving air quality, restoring ecosystems and biodiversity, and enhancing property values and economic vitality.

Accelerating and scaling NBS will require public-private partnerships (PPPs) and a community-driven approach. Implementing NBS on the individual or single-asset level would likely not add as much value as a unified or community-driven approach. For example, a homeowner can begin targeted tree plantings on their property, but if a home next door fails to plant trees and the public land between homes does not have sustainable urban drainage, the positive externalities will be minimized. Furthermore, NBS must be implemented with a multi-hazard mindset. For example, tree plantings near homes in certain areas can increase overall wildfire risk. Therefore, implementing NBS requires the community-driven approach of uniting public and private leaders with other key stakeholders to capitalize on the benefits while mitigating risks.

FIGURE 5 **Sector breakdown of investment opportunities for NBS**



4 Call to action for the insurance industry and public sector

Insurers and policy-makers have the capacity, risk exposure and societal obligation to tackle the challenges posed by extreme heat.

Insurance industry

The insurance industry is at the forefront of the rapidly evolving extreme heat risk landscape. While the insurance industry is not responsible for creating growing climate risks, the industry can – and should – act with urgency, leading the development of innovative strategies to mitigate heat risk and help economies and societies adapt to this evolving threat. Insurance leaders must seize this moment to prioritize heat risk in their strategic planning, invest in forward-thinking solutions and collaborate with public and private sectors to build a more resilient future for vulnerable communities and industries. As large asset owners, once appropriate funds are stored to pay claims, insurers can use their capital to drive forward high-impact resilience and adaptation interventions.

Leaders working at the intersection of insurance and climate resilience must consider how to adapt their products and risk-sharing mechanisms to extreme heat. For example, insurance products and partnerships applied to flood risk in the past could be adapted to extreme heat. Mobilizing financial capital for flood resilience, building strategic protection in infrastructure and using innovative financial mechanisms – such as resilience bonds – have helped manage flood risk in the past and could be retrofitted to address extreme heat.[65] Insurance partnerships for flood resilience, such as the National Flood Insurance Program's (NFIP) community rating programme – which offers reduced premiums to communities that invest in flood mitigation – could be adapted for communities with certified heat action plans. Insurers could provide rebates or premium discounts for investments that improve resilience to extreme heat. Coastal resilience risk transfer mechanisms, such as parametric insurance for coral reef protection, demonstrated that the long-term risk reduction benefits vastly outweighed the costs of premium reductions offered by the insurance industry. Similar structures could be applied to an insurance-based extreme heat resilience framework.[66]

TABLE 2 **Marsh McLennan is presenting different pathways to adapt people, systems and economies from extreme heat risk to underpin innovative extreme heat risk management mechanisms**

Three ways to transform extreme heat risk management	Examples of innovative strategies and solutions
 **Learning to live with extreme heat** Build resilience for people, communities and own assets to extreme heat events	– Raise awareness and address employee and community health-related risks through education programmes, improved early warning systems, cooling centres and adjusted working patterns – Promote asset-level adaptation such as engineered- and natural-cooling measures, and smart building materials – Leverage parametric solutions to build financial resilience to extreme heat-relate disruptions, including communities in LMICs – Develop heat-resistant crops, medication and food supplies – Assess and amend benefits to cover employees and their families
 **Building system-level protections** Implement large scale interventions to protect critical assets and ensure financial resilience to extreme heat and its compound consequences	– Build wider contingency into business operations by managing the impact of supplier disruptions due to extreme heat and associated risks – Invest in retrofitting critical infrastructure to withstand greater temperatures – Implement integrated national health management approaches – Enhance resilience by considering adaptation measures to ecosystem services exposed to extreme heat and associated risks

 **Prepare for adaptation limits** Consider wholesale changes to entire regions and systems to address breach of temperature thresholds that exceed human and ecosystem health	– Leverage state-of-the-art climate risk models to consider transformative adaptation options beyond threshold scenarios, including:
	  – Redesigning cities and buildings
	  – Incentive programs for community relocation
	  – Planning sectoral transitions away from heat or water scarce areas
	  – Promoting social welfare through equitable relocations and transition
	– Develop flexible strategies that evolve with changing climate conditions and societal needs to prevent or delay reaching adaptation limits

Source: Marsh McLennan. (2024). Turning down the heat. https://www.marshmclennan.com/web-assets/insights/publications/2024/novemvber/extreme-heat-report.pdf.

“ The insurance industry could collaborate on comprehensive data collection to identify the costs of extreme heatwaves and the benefits of resilience interventions.

The insurance industry can develop innovative and bespoke solutions to address the unique risk landscape posed by extreme heat. Insurers should continue to develop their extreme heat risk data collection strategies, deepen research efforts and strengthen partnerships with key stakeholders to develop innovative solutions products that effectively address the challenges of extreme heat. Partnerships will be critical for bridging the gap between existing insurance frameworks for climate resilience and the unique risk landscape presented by extreme heat. The insurance industry – particularly climate modellers, atmospheric scientists and underwriters – could collaborate on comprehensive data collection to identify the costs of extreme heatwaves and the benefits of resilience interventions. Data sharing and collection would allow both public and private actors to assess their exposure and determine appropriate responses.

More broadly, insurance is no longer simply in the business of paying claims – the industry is evolving to play a more active resilience-building role across economies and societies. Insurers should do more to use their risk expertise to promote prevention and preparedness. They can work more closely with society to expand the insurer’s value proposition to include supporting customers’ adaptation, mitigation and resilience measures. When insurers play a more prominent and expanded risk-consulting role, it broadens the insurance value proposition and enhances preparedness, increases resilience, reduces losses and business interruptions, and extends insurability to higher-risk cases and areas. Insurers can design risk-transfer mechanisms that encourage risk-reducing behaviours, similar to past successful examples like lowering car insurance premiums for safe drivers or home insurance premiums for fire-resistant structures. Insurers can also broaden their value through risk education, which is vital to accelerating risk reduction across businesses and communities. Industry leaders must continue to work towards unlocking risk-reducing investments such as heat-resilient infrastructure and NBS, which drive long-term heat mitigation. These measures are typically the most effective with a few key criteria:

> Heat-related deaths are often underestimated; the true costs of the disaster are more long-tail in nature and often not fully understood until months later.

- Clear and effective measures (where available) to reduce risk in the context of rising insurance losses
- Affordability and attainability for homeowners or communities
- Advancing measures that align with the established business models, financial interests of insurance companies and consumer concerns[67]

This new direction and outlook for the insurance industry strengthens its relationship with customers by providing peace of mind, risk awareness, loss mitigation and community resilience. By embracing innovative solutions, building new partnerships and taking a more active role in resilience-building, the insurance industry can mitigate the growing risks of extreme heat. In doing so, it can transform itself into a proactive force that enhances societal preparedness, safeguards communities and strengthens long-term economic stability in the face of climate change.

Policy-makers

Record-breaking temperatures are pushing policy-makers to engage with regulators and insurers to address the impacts of extreme heat. While insurance is vital in managing risk and responding to losses, extreme heat will require a uniquely collaborative approach to address its far-reaching impacts. Policy-makers and government officials will play an essential role in creating targeted policies to address extreme heat and ensuring that insurance remains affordable and attainable in risk-prone communities.

Officially recognizing and addressing extreme heat is a key first step to an effective policy measure. In the US, for example, the Federal Emergency Management Agency (FEMA) does not classify extreme heat as a natural disaster and, therefore, cannot mobilize much-needed capital to vulnerable communities and economies.[68] In 2022, when California requested federal help with heat-induced wildfires, their requests were denied. This is largely due to the Stratford Act, a 1965 piece of US legislation designating 16 disasters in FEMA's jurisdiction. Codifying extreme heat alongside other traditional "peak perils" such as hurricanes or tornadoes would unlock vital federal funding to build community resilience and fund long-term adaptation strategies such as urban planning initiatives to increase green spaces and improve building insulation.

From a policy standpoint, defining what constitutes an extreme heat disaster is not straightforward, and the thresholds for a heatwave to be classified as a named disaster could be very high. These thresholds would likely be based on a combination of factors beyond high temperatures, including humidity, geography and the number of vulnerable residents. Another key factor is a community's level of acclimatization to high temperatures – a stretch of 35°C days may not be considered a heat disaster in India, but that same heat could be disastrous in London, where people and infrastructure are not adapted to high temperatures. Data collection on heat impacts is also a roadblock for creating heat resilience policies, making typical insurance principles of assessing losses and providing payouts less easily applied.[69] For example, heat-related deaths are often underestimated; the true costs of the disaster are more long-tail in nature and often not fully understood until months later.[70]

Furthermore, policy-makers should prioritize extreme heat in local, regional and national adaptation planning. This includes crowding in private investment in key adaptation investments – currently, only 2% of adaptation financing comes from the private sector.[71] Private investment in adaptation, in partnership with governments, the International Monetary Fund (IMF), the World Bank and other key multilateral actors, will be critical to bridging the adaptation funding gap. There are also more bespoke policies that could manifest as PPPs to help communities, including communications interventions, air conditioner loans before an expected heatwave, funding for cooling centres, subsidized access to privately owned cool spaces such as libraries or cinemas, and additional staff at public hospitals during a heatwave. Governments can further incentivize heat action plans by pairing these goods and services with a codified heat plan.

Additionally, policy-makers can and should play a key role in innovative financial mechanisms to address extreme heat. Many effective disaster risk reduction and risk transfer frameworks are built on multistakeholder partnerships to allow for philanthropic support and/or low-risk loans. This is exemplified by the Caribbean Catastrophe Risk Insurance Facility (CCRIF), which provides disaster risk financing products and services and supports multiple countries which ensures maximum risk pooling.[72]

Finally, policy-makers and regulators can collaborate more closely with the insurance industry to create a regulatory and policy environment that ensures insurance remains both affordable and accessible in climate-risk-prone communities. In December 2024, California's Insurance Commissioner passed landmark regulations aimed at stabilizing the state's troubled home insurance market. This framework allows insurers to use a broad range of meteorological, geographic and other data to set rates, reducing reliance on historical loss data and allowing companies to apply their scientific models directly to the market. In return, major insurance companies are required to maintain a stronger presence in wildfire-risk-prone areas. The regulation also introduces greater transparency in catastrophe risk modelling, including creating a first-of-its-kind public wildfire catastrophe model, while preserving proprietary elements of the models that underpin insurers' underwriting practices. Finally, the regulation allows insurance companies to account for reinsurance coats in rate-making for wildfire distressed regions of the state.

This development underscores the critical role of collaboration among policy-makers, regulators and insurers in maintaining an affordable and sustainable insurance market in an era of intensifying climate challenges.[73]

CASE STUDY 9

Madrid's partnership with Zurich Resilience Solutions

Madrid is warming rapidly, in large part due to the heat island effect. It is highly urbanized, covered in concrete and asphalt, and recent studies of urban extreme heat showed temperatures 8.5°C hotter than rural surroundings. In recent years, warming has been so severe that it has fundamentally altered the historical seasonal patterns of the city.[74]

To build and sustain heat resilience, Madrid City Council partnered with Zurich Insurance's risk consulting arm, Zurich Resilience Solutions (ZRS), to integrate its climate data and risk management expertise into the city's climate adaptation strategy. ZRS helped identify and quantify Madrid's short- and long-term heat exposure and identified key measures to bolster climate resilience and adapt to more frequent and intense heatwaves.[75] To address these challenges, Madrid is currently in the process of implementing NBS, replacing hard surfaces with green spaces, altering working hours to protect vulnerable workers and implementing heat-reflecting materials on buildings.

CASE STUDY 10

Naming and ranking heatwaves

Hurricanes and floods have long been accompanied by naming and categorization systems, paired with emergency response infrastructure to safeguard vulnerable communities. However, until recently, there was no such system for extreme heat.

In 2022, the Atlantic Council's Climate Resilience Center introduced the world's first protocol for naming and categorizing heatwaves. By classifying these events according to their severity, communities can take proactive measures to protect themselves, while governments can more effectively allocate funding, services and support to affected areas. Naming a heatwave also elevates its social significance, similarly to hurricanes – consider the stark difference in impact between "Louisiana Hurricane 2005" and "Hurricane Katrina".

In July 2022, the city experienced Heatwave Zoe, marking the first time a heatwave was officially named in advance of a dangerous event. More cities must adopt this policy to enhance preparedness and response to the increasingly frequent and intense heatwaves of the future.

These policy pathways allow government, insurers and business leaders to collaborate and innovate to develop extreme heat resilience products and partnerships. The urgent need for extreme heat mitigation and adaptation makes the value of these mechanisms abundantly clear. The foundations for these partnerships will begin with good faith dialogue, exemplified by a first-of-its-kind extreme heat summit at the White House this year.[76] Policy-makers play a role in addressing the impacts of the full spectrum of climate risks. Still, the far-reaching impact of extreme heat requires especially strong buy-in from the public sector to enable innovative insurance and financing mechanisms.

Conclusion

As the world faces the growing consequences of extreme heat, the insurance industry, policy-makers and other key stakeholders are adopting strategies to mitigate its impacts and protect vulnerable communities and economies. The evidence is clear: extreme heat is reshaping the global risk landscape by creating new vulnerabilities and exacerbating existing ones. Its effects are not only immediate – resulting in loss of life and damage to infrastructure – but also far-reaching, with severe economic implications, particularly in regions with significant insurance protection gaps and limited resources for adaptation. Communities most vulnerable to climate disasters often face significant barriers to accessing insurance, limiting the reach and impact of even the most innovative insurance solutions. For these initiatives to succeed, they must be paired with effective distribution channels and fostered by strong community engagement to ensure widespread participation and impact.

As daunting as the challenges are, today's risk landscape presents opportunities for adaptation, resilience building and innovation. Governments, businesses, insurers and other key stakeholders can mitigate risks and protect vulnerable populations while investing in solutions to reduce long-term damage. For insurers and policy-makers, using innovative financial mechanisms and incorporating climate resilience into business and policy frameworks will be key strategies in addressing the multifaceted risks posed by extreme heat. Business leaders and governments can capitalize on emerging opportunities for a host of jobs, skills development and economic activity in furtherance of resilience and adaptation projects.

Over the past two years, the World Economic Forum has convened workshops and published thought leadership with executives at the intersection of insurance and climate resilience alongside key stakeholders from government, philanthropy, multilateral institutions and regulators. The goal has been to identify challenges and map out insurance strategies that strengthen and sustain resilience to extreme heat. The Forum will continue to use its platform for public-private collaboration to stimulate this crucial dialogue and drive impact on this critical issue.

While this report centres on the roles of the insurance industry and policy-makers in addressing extreme heat, this challenge demands a holistic all-of-society approach. Tackling extreme heat requires the involvement of wide range of stakeholders (including utilities providers, scientists, public health officials, infrastructure planners, media, mayors and local government, and leaders from highly-exposed sectors like real estate, agriculture, construction, and manufacturing) to develop community-based and sector-specific heat resilience strategies.

Individuals and communities also play a critical role in risk reduction through actions such as adopting renewable energy, retrofitting homes for physical climate resilience and enhancing local preparedness. More time and attention should be devoted to educating individuals and communities on risk reduction and prevention measures. Both the impact of extreme heat and the tools to adapt to these risks are unevenly distributed, disproportionately affecting the poor, racial minorities and other vulnerable groups. Risk education and adaptation efforts must be approached through an equity-centered lens to ensure that those who need to build resilience the most are able to do so. Ultimately, these actions at the individual and community levels significantly impact the insurance landscape and are essential to mitigating this growing crisis. Given the urgent need for multistakeholder collaboration to enhance extreme heat resilience, the insights from this report will serve as the foundation for a cross-industry, research-driven initiative focused on this issue throughout 2025.

The growing challenge of extreme heat coordinated proactive action. The cost of inaction – measured in human lives, economic losses and societal disruption – is simply too high. Decisions made today will shape how well the world endures and adapts to a fast-warming world in the future.

Contributors

Lead author

Daniel Murphy
Industry Community Specialist,
World Economic Forum

Acknowledgements

Amy Barnes
Head, Climate and Sustainability Strategy,
Marsh McLennan

Kathy Baughman McLeod
Chief Executive Officer, Climate Resilience for All

Andre Belelieu
Head, Financial Services Industries,
World Economic Forum

Kalin Bracken
Manager, Real Estate Industry,
World Economic Forum

Ange Chitate
Chief Operating Officer, Africa Risk Capacity

Anne Christianson
Resilience and Adaptation Lead,
World Economic Forum

Julie Dick
Senior Resilience Policy Advisor,
Miami Dade County

Gabrielle Durisch
Chief Sustainability Officer, Allianz Commercial

Sarah Ebrahimi
Head, Institutional Partnerships, Blue Marble

Gill Einhorn
Head of Innovation and Transformation,
World Economic Forum

Jorge Gastelumendi
Director, Global Policy, Atlantic Council

Jane Gilbert
Chief Heat Officer, Miami Dade County

Maryam Golnaraghi
Director, Climate Change and Environment,
The Geneva Association

Cherie Gray
Global Lead, Sustainability & Market Development,
Swiss Re

Annika Greene
Climate and Health Lead,
World Economic Forum

Deborah Halberstdat
Special Advisor to the Commissioner,
Inclusive Insurance & Biodiversity

Graham Hall
Actuarial Director, Catastrophe Risk,
Climate Change and AI, PricewaterhouseCoopers

Kipkorir Koskei
Director, Strategic Partnerships,
Insurance Development Forum

Carolyn Kousky
Associate Vice-President, Economics and Policy,
Environmental Defense Fund

Danae Kyriakopoulou
Co-Head, Climate Hub, Bank of England

Ricardo Lara
Insurance Comissioner, State of California

Steven Lewis
Global Head of Insight, JLL

Tobias Lindstrom Battle
Project Specialist, Climate and Health,
World Economic Forum

Jeff Manson
Head, Global Public Sector Partnership,
RenaissanceRe

John Maroney
Chief Executive Officer, Global Asia Insurance
Partnership (GAIP)

Sonny Masero
Managing Director,
ESG Intelligence and Strategy, Hines

Robert McDonald
Lead Scientist, Global Cities Program,
Nature Conservancy

Masaaki Nagamura
Fellow, International Initiatives,
Tokio Marine Holdings

Judith Neumann
Global Head, Industry Advisory for Sustainability and Climate Resilience, Guidewire Software

Kevin O'Donnell
President and Chief Executive Officer,
RenaissanceRe Holdings

Takahiro Ono
General Counsellor, Sustainability Division,
Tokio Marine Holdings

Coen van Oostrom
Founder and Chief Executive Officer,
EDGE

Martin Powell
Head of Sustainability, AXA

Amar Rahman
Global Head, Climate Resilience Services,
Zurich Insurance

Mauricio Rodas
Senior Fellow, Atlantic Council

Veronica Scotti
Chairperson, Public Sector Solutions, Swiss Re

Tapan Singhel
Managing Director; Chief Executive Officer,
Bajaj Allianz General Insurance

Swenja Surminiski
Managing Director, Climate and Sustainability,
Marsh McLennan

Craig Tillman
President, RenaissanceRe Risk Sciences

Veronika Torarp
Climate Strategy Insurance Partner,
PricewaterhouseCoopers

Michael Walz
Senior Product Manager, Parametric Solutions,
Swiss Re

Maria Zou
Senior Product Manager, Life and Health, Swiss Re

Production

Laurence Denmark
Creative Director, Studio Miko

Jay Kelly
Designer, Studio Miko

Will Liley
Editor, Studio Miko

Endnotes

1. Basu, R., Gavin, L., Pearson, D., Ebisu, K., et al. (n.d.). *Examining the association between apparent temperature and mental health-related emergency room visits in California*. PubMed. https://pubmed.ncbi.nlm.nih.gov/29020264/.
2. U.S. Chamber of Commerce. (2024). *The Preparedness Payoff: The Economic benefits of Investing in Climate Resilience*. https://www.uschamber.com/security/the-preparedness-payoff-the-economic-benefits-of-investing-in-climate-resilience.
3. Climate Central, World Weather Attribution and Red Crescent Climate Centre. (2024). *Climate change and the escalation of global extreme heat*. https://www.climatecentral.org/report/climate-change-and-the-escalation-of-global-extreme-heat.
4. Magdy, S. (2024). *More than 1,300 people died during Hajj, many of them after walking in the scorching heat*. AP News. https://apnews.com/article/hajj-heat-deaths-mecca-saudi-arabia-pilgrimage-9f97aae1032b14ada29bbea7108195d3.
5. World Meteorological Organization (WMO). (2024). *UN Secretary-General issues call to action on extreme heat* [Press release]. https://wmo.int/news/media-centre/un-secretary-general-issues-call-action-extreme-heat-0.
6. Adams-Fuller, T. (2024). *Extreme Heat Is Deadlier Than Hurricanes, Floods, and Tornadoes Combined*. Scientific American. https://www.scientificamerican.com/article/extreme-heat-is-deadlier-than-hurricanes-floods-and-tornadoes-combined/.
7. Swiss Re. (2024). *Sonar 2024: New emerging risk insights*. https://www.swissre.com/institute/research/sonar/sonar2024.html.
8. Rhyne, E. (2022). *Extreme Heat Will Change Us*. The New York Times. https://www.nytimes.com/interactive/2022/11/18/world/middleeast/extreme-heat.html#:~:text=By%202050%2C%20nearly%20half%20the,and%20the%20University%20of%20Washington.
9. Flavelle, C. (2021). *Climate Change Could Cut the World Economy by $23 Trillion in 2050, Insurance Giant Warns*. https://www.nytimes.com/2021/04/22/climate/climate-change-economy.html#:~:text=483-,Climate%20Change%20Could%20Cut%20World%20Economy%20by%20%2423%20Trillion%20in,and%20invests%20its%20mammoth%20portfolios
10. Messieh, N. (2023). *Heat is killing us—and the economy too*. Atlantic Council. https://www.atlanticcouncil.org/content-series/the-big-story/heat-is-killing-us-and-the-economy-too/.
11. Eavis, P. and N. Angarita. (2023). *Drought saps the Panama Canal, disrupting global trade*. The New York Times. https://www.nytimes.com/2023/11/01/business/economy/panama-canal-drought-shipping.html.
12. Topping, A. (2022, 20 July). Heatwave led to London firefighters' busiest day since second world war. *The Guardian*. https://www.theguardian.com/uk-news/2022/jul/20/heatwave-led-to-london-firefighters-busiest-day-since-second-world-war.
13. BBC News. (2022). *Hammersmith Bridge wrapped in foil during heatwave*. https://www.bbc.com/news/uk-england-london-62162687.
14. Bhattacharya-Craven, A., M. Golnaraghi, M. Thomson and T. Caplan. (2024). *Climate Change: What does the future hold for health and life insurance?* The Geneva Association. https://www.genevaassociation.org/publication/climate-change-and-environment-health-and-demography/climate-change-what-does-future.
15. Zhao, Q., Y. Guo, T. Ye, A. Gasparrini, et al. (2021). Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: a three-stage modelling study. *Lancet Planet Health*, vol. 5, no. 7. https://pubmed.ncbi.nlm.nih.gov/34245712/.
16. Ioannou, L. G., Tsoutsoubi, L., Mantzios, K., Vliora, M., et al. (2022). Indicators to assess physiological heat strain – Part 3: Multi-country field evaluation and consensus recommendations. *Temperature*, vol. 9, no. 3, pp. 274-291. https://doi.org/10.1080/23328940.2022.2044739.
17. National Oceanic and Atmospheric Administration. (n.d.). *Wet Bulb Globe Temperature: How and when to use it*. https://www.weather.gov/news/211009-WBGT.
18. Azzi, M. (2024). *Climate change creates a "cocktail" of serious health hazards for 70 percent of the world's workers*. International Labour Organization (ILO). https://www.ilo.org/resource/news/climate-change-creates-cocktail-serious-health-hazards-70-cent-worlds.
19. Occupational Safety and Health Administration. (n.d.). *Overview: Working in Outdoor and Indoor Heat Environments*. https://www.osha.gov/heat-exposure#:~:text=Millions%20of%20U.S.%20workers%20are,have%20suffered%20heat%2Drelated%20illnesses.
20. Omoloja, A., Jerry-Fluker, J., Ng, D. K., Abraham, A. G., et al. (2013). Secondhand smoke exposure is associated with proteinuria in children with chronic kidney disease. *Pediatr Nephrol*, vol. 28, no. 8, pp. 1243-1251. https://www.ncbi.nlm.nih.gov/pmc/articles/PMC3703840/.
21. Dasgupta, S., N. van Maanen, S. N. Gosling, F. Piontek, et al. (2021). Effects of climate change on combined labour productivity and supply: An empirical, multi-model study. *The Lancet Planetary Health*, vol. 5, no. 7, pp. 455-465. https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(21)00170-4/fulltext.
22. Green, A. et al. (2024). *Quantifying the Impact of Climate Change on Human Health. World Economic Forum*. https://www.weforum.org/publications/quantifying-the-impact-of-climate-change-on-human-health/.
23. Emanuel, K. (2024). *Convergence: Risk modelling 'not fit for purpose'*. Bermuda:Re+ILS. https://www.bermudareinsurancemagazine.com/convergence-risk-modelling-not-fit-for-purpose.

24. Verisk. (2023). *Insurance Industry Faces Average Annual Natural Catastrophe Losses of $133B, A New High, According to Verisk Report*. https://www.verisk.com/company/newsroom/insurance-industry-faces-average-annual-natural-catastrophe-losses-of-$133b-a-new-high-according-to-verisk-report/.
25. Fellowes-Granda, L. (2024). *4 Principles for Addressing Climate Risks in the Insurance Industry*. American Progress. https://www.americanprogress.org/article/4-principles-for-addressing-climate-risks-in-the-insurance-industry/.
26. Doerr, S. H., C. Santín, J. Abatzoglou, M. W. Jones, et al. (2022). *Climate change: wildfire risk has grown nearly everywhere – but we can still influence where and how fires strike*. The Conversation. https://theconversation.com/climate-change-wildfire-risk-has-grown-nearly-everywhere-but-we-can-still-influence-where-and-how-fires-strike-185465.
27. Freedman, A. and Bomey, N. (2023). *Uninusrable America: Climate Change Hits the Insurance Industry*. Axios. https://www.axios.com/2023/06/06/climate-change-homeowners-insurance-state-farm-california-florida.
28. Munce, M. F. (2024). *California's home insurance crisis is getting worse—but rates are still cheap compared to Florida*. San Francisco Chronicle. https://www.sfchronicle.com/california/article/california-florida-home-insurance-19798573.php.
29. State Farm. (2024). *State Farm in California: Understanding the issues.* https://newsroom.statefarm.com/state-farm-in-california-understanding-the-issues/.
30. Bartlam, T., Intagliata, C. and Chang, A. (2023). *California's wildfire risk is so high and costly, some insurers are leaving the state*. NPR. https://www.npr.org/2023/06/14/1182238344/californias-wildfire-risk-is-so-high-and-costly-some-insurers-are-leaving-the-st.
31. State Farm. (2024). *State Farm in California: Understanding the issues.* https://newsroom.statefarm.com/state-farm-in-california-understanding-the-issues/.
32. Breslin, E. (2023). *California Awards $21.7 Million to Bolster Regional-Scale Climate Resilience Across the State*. CA.GOV. https://lci.ca.gov/news/2023/12-21.html#:~:text=In%20the%20first%20round%2C%20California,partnerships%20serving%20predominantly%20Disadvantaged%20Communities.
33. LegiScan. (2024). *California Senate Bill 219: Greenhouse gases: climate corporate accountability: climate-related financial risk*. https://legiscan.com/CA/text/SB219/id/3020334.
34. California Department of Insurance. (2021). *Protecting Communities, Preserving Nature and Building Resiliency*. https://content.naic.org/article/california-department-insurance-protecting-communities-preserving-nature-and-building-resiliency.
35. Libatique, R. (2024). *Soaring premiums push 1.6 million Aussie households into insurance crisis*. Insurance Business. https://www.insurancebusinessmag.com/au/news/property/soaring-premiums-push-1-6-million-aussie-households-into-insurance-crisis-502802.aspx#:~:text=Regions%20facing%20insurance%20affordability%20issues,high%20flood%20and%20cyclone%20risks.
36. McKinsey & Company. (2023). *Global Insurance Report 2023: Navigating Asia's evolving market*. https://www.mckinsey.com/industries/financial-services/our-insights/global-insurance-report-2023-navigating-asias-evolving-market.
37. Swiss Re. (2023). *How big is the protection gap from natural catastrophes where you are?* https://www.swissre.com/risk-knowledge/mitigating-climate-risk/natcat-protection-gap-infographic.html#/country/India.
38. Haegeli, J. et al. (2024). *Resilience Index 2024: Encouraging Resilience Gains, but More is Needed*. SwissRe Institute. *chrome-extension://efaidnbmnnnibpcajpcglclefindmkaj/https://www.swissre.com/dam/jcr:577c79d6-b015-41fd-9eee-47927efb2136/sigma-resilience-index-2024.pdf*.
39. Marsh McLennan. (n.d.). *Parametrics*. https://www.marsh.com/en/services/parametrics.html.
40. Martin, A., R. Nusslein, M. Hotz, A. Baer, et al. (2023). *What is parametric insurance?* Swiss Re. https://corporatesolutions.swissre.com/insights/knowledge/what_is_parametric_insurance.html.
41. AXA. (n.d.). *AXA Launches Pioneering Heatwave Parametric Insurance*. https://www.axa.com.hk/en/article/axa-launches-pioneering-heatwave-parametric-insurance.
42. Swiss Re. (2023). *CatNet: Redefining wildfire underwriting*. https://www.swissre.com/reinsurance/property-and-casualty/solutions/property-solutions/catnet/catnet-wildfire-underwriting-accuracy.html.
43. Arribas, A., Fairgrieve, R., Dhu, T. et al. (2022). Climate risk assessment needs urgent improvement. *Nature Communications*, vol. 13, no. 4326. https://doi.org/10.1038/s41467-022-31979-w.
44. Marsh McLennan. (2024, 2 May). *Marsh McLennan Launches AI-Powered Solution to Transform Supply Chain Risk Management* [Press release]. https://www.marshmclennan.com/news-events/2024/may/marsh-mclennan-launches-ai-powered-solution-to-transform-supply-chain-risk-management.html.
45. United Nations (UN). (2023). *Climate resilience and insurance*. https://www.un.org/en/climate-resilience-and-insurance.
46. Shakerian, S. et al. (2021). Assessing occupational risk of heat stress at construction: A worker-centric wearable sensor-based approach. *Safety Science*, vol. 142, no. 105395. https://www.sciencedirect.com/science/article/pii/S0925753521002393.
47. European Insurance and Occupational Pensions Authority. (2024, 3 September). *Leveraging insurance to shore up Europe's climate resilience*. https://www.eiopa.europa.eu/leveraging-insurance-shore-europes-climate-resilience-2024-09-03_en.
48. Hemingway Jaynes, C. (2022, 31 March). *UN calls for extreme weather warning systems for everyone on Earth within 5 years*. https://www.weforum.org/agenda/2022/03/un-extreme-weather-warning-systems-2030/.
49. Chitate, A. (2023). *How early warning systems and parametric insurance can build climate resilience in Africa*. World Economic Forum. https://www.weforum.org/agenda/2024/07/early-warning-systems-parametric-insurance-climate-resilience-africa/.

50. United Nations Office for Disaster Risk Reduction (UNDRR), World Meteorological Association (WMO), International Telecommunication Union (ITU) and International Federation of Red Cross and Red Crescent Societies (IFRC). (2023). *Early warnings for all*. https://www.un.org/en/climatechange/early-warnings-for-all.
51. World Meteorological Organization (WMO). (2024, 18 October). *Greater Investment in climate services for health needed for escalating challenges*. https://wmo.int/media/news/greater-investment-climate-services-health-needed-escalating-challenges.
52. Wickerson, G. (2024). *Hot Policy Ideas to Tackle the Extreme Heat Crisis*. Federation of American Scientists. https://fas.org/accelerator/extreme-heat-policy-challenge/.
53. Western Sydney Regional Organisation of Councils (WSROC). (n.d.). *Greater Sydney Heat Taskforce*. https://wsroc.com.au/projects/project-turn-down-the-heat/greater-sydney-heat-taskforce.
54. Andreoni, M. (2024, 2024, 21 May). *How India is Coping with Extreme Heat*. The New York Times. https://www.nytimes.com/2024/05/21/climate/india-extreme-heat.html.
55. Hess, J. J., Sathish, L. M., K. Knowlton, S. Saha, et al. (2018). Building Resilience to Climate Change: Pilot Evaluation of the Impact of India's First Heat Action Plan on All-Cause Mortality. *Journal of Environmental and Public Health*, 1 November 2018. https://onlinelibrary.wiley.com/doi/10.1155/2018/7973519.
56. Natural Resources Defense Council (NRDC). (2023). *The Story of India's First State-wide Cool Roof Policy*. https://www.nrdc.org/sites/default/files/2023-12/cool-roofs-policy-factsheet-20231207.pdf.
57. The New Indian Express. (2024). *AIIMS-Bhubaneswar opens heat stroke unit*. https://www.newindianexpress.com/states/odisha/2024/Apr/26/aiims-bhubaneswar-opens-heat-stroke-unit.
58. Limaye, V. (2024). *Workshop Accelerates Heat Preparedness Action in India*. Natural Resources Defense Council (NRDC). https://www.nrdc.org/bio/vijay-limaye/workshop-accelerates-heat-preparedness-action-india.
59. Rochman, S. (2022, 18 March). *Neighborhood green space tied to lower health care costs*. Kaiser Permanente. https://divisionofresearch.kaiserpermanente.org/blog/2022/03/18/green-space-health-care-costs/.
60. World Economic Forum. (2022). *BiodiverCities by 2030: Transforming cities' relationship with nature*. https://www.weforum.org/publications/biodivercities-by-2030-transforming-cities-relationship-with-nature/.
61. Ibid.
62. United Nations Department of Economic and Social Affairs. (2018). *Around 2.5 billion more people will be living in cities by 2050, projects new UN report*. https://www.un.org/en/desa/around-25-billion-more-people-will-be-living-cities-2050-projects-new-un-report.
63. McDonald, R. et al. (2024). *Roots of Resilience: Using Trees to Mitigate Rising Heat in Arid, Frontline Communities*. The Nature Conservancy.
64. United States Environmental Protectino Agency (EPA). (n.d.). *Learn About Heat Islands*. https://www.epa.gov/heatislands/learn-about-heat-islands.
65. Surminski, S. (2023). *Staying above water: A systemic response to rising flood risk*. Marsh McLennan. https://www.marshmclennan.com/content/dam/mmc-web/insights/publications/2023/february marshmclennanstayingabovewater.pdf.
66. Reguero, B. G., M. W. Beck, D. Schmid, D. Stadtmüller, et al. (2020). Financing coastal resilience by combining nature-based risk reduction with insurance. *Ecological Economics*, vol. 169. https://doi.org/10.1016/j.ecolecon.2019.106487.
67. Farber, S. (2011). Paying for Ecosystem Services: Promise and Peril. *Science*, vol. 334. https://www.researchgate.net/publication/51769835_Paying_for_Ecosystem_Services-Promise_and_Peril.
68. Borunda, A. (2024). *Why isn't extreme heat considered a disaster in the U.S.?* NPR. https://www.npr.org/2024/06/18/nx-s1-5003785/extreme-heat-disaster-fema-climate.
69. World Meteorological Organization (WMO). (2023). *2023 State of Climate Services – Health*. https://library.wmo.int/viewer/68500/download?file=1335_WMO-Climate-services-Health_en.pdf&type=pdf&navigator=1.
70. Wittenberg, A. and C. Harvey. (2024). *U.S. deaths from heat are dangerously undercounted*. Scientific American. https://www.scientificamerican.com/article/u-s-deaths-from-heat-are-dangerously-undercounted/.
71. Choi, E., E. Jang and V. Laxton. (2023). *What It Takes to Attract Private Investment to Climate Adaptation*. World Resources Institute. https://www.wri.org/insights/private-sector-climate-adaptation-finance#:~:text=While%20adaptation%20finance%20can%20come,more%20resilient%20is%20not%20included.
72. United Nations Climate Change. (n.d.). *The Caribbean Catastrophe Risk Insurance Facility (CCRIF)*. https://unfccc.int/topics/adaptation-and-resilience/resources/S-N/CCRIF.
73. Darmiento, L. (2024, 13 December). *California issues landmark rules to improve home insurance market*. Los Angeles Times. https://www.latimes.com/business/story/2024-12-13/california-home-insurance-catastrophe-modeling-insurance-commissioner-laraa.
74. Allen, D. (2023). *Madrid suffers most extreme urban heat island "hot spot" – new international survey shows*. Arup. https://www.arup.com/news/madrid-suffers-most-extreme-urban-heat-island-hot-spot--new-international-survey-shows/.
75. McAllister, S. (2024). *Madrid's battle against extreme heat: How Zurich has been helping enhance the city's climate resilience*. Zurich. https://www.zurich.com/media/magazine/2024/madrids-battle-against-extreme-heat.
76. The White House. (2024). *FACT SHEET: President Biden Announces New Actions to Protect Workers and Communities from Extreme Weather*. https://www.whitehouse.gov/briefing-room/statements-releases/2024/07/02/fact-sheet-president-biden-announces-new-actions-to-protect-workers-and-communities-from-extreme-weather/.

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World Economic Forum
91–93 route de la Capite
CH-1223 Cologny/Geneva
Switzerland

Tel.: +41 (0) 22 869 1212
Fax: +41 (0) 22 786 2744
contact@weforum.org
www.weforum.org