Ten Years of the Paris Agreement: The Present and Future of Extreme Heat

A global analysis of how extreme heat has changed since the signing of the 2015 Paris Agreement and how current pledges to reduce emissions will shape the future of extreme heat on Earth.

KEY MESSAGES

- The Paris Agreement provides an important legal and political framework toward a safer and fairer world. Projected warming this century has dropped from about 4°C in 2015 to 2.6°C today — if current emissions reduction pledges are fully implemented.
- However, 2.6°C of warming would still lead to a dangerously hot planet. Every fraction of a degree of warming results in more frequent and intense heat. The world now experiences an average of 11 more hot days per year with the additional 0.3°C of warming since 2015. In a 2.6°C world, that increases to 57 extra hot days per year compared to now; at 4°C, that rises to an additional 114 hot days per year.
- Case studies in this report confirm that extreme heat waves have already become more likely since 2015. Three of the six events studied would have been nearly impossible without climate change, and two of those are now about 10 times more likely to occur in 2025 than in 2015.
- Since 2015, heat early warning systems and action plans have expanded worldwide, but progress is insufficient and is slowed by limited financing for heat adaptation at the local level.
- The costs of inaction on extreme heat are rising faster than adaptation. Health, labor, and infrastructure are under strain, adaptation finance is insufficient, and the most vulnerable risk being left behind unprepared.
- The expected warming this century is still far above the Paris goals of keeping warming to 1.5°C and well below 2°C. The highest possible ambition as set out in the Paris Agreement to achieve deep, rapid, and sustained emissions reductions is urgently needed.

Suggested citation: Arrighi, Dahl, Giguere, Keeping, Otto, Singh, Tannenbaum, Vahlberg, et al. (2025). *Ten Years of the Paris Agreement: The Present and Future of Extreme Heat*. Climate Central, World Weather Attribution. https://climatecentral.org/report/10th-anniversary-paris-agreement.

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Major funding provided by the Bezos Earth Fund

World Weather Attribution (WWA) is an international group of scientists that investigates how climate change influences the intensity and likelihood of extreme weather events, such as heat waves, floods, and droughts. WWA uses weather observations and climate models, and prioritizes events to analyze based on fixed criteria, such as the humanitarian impact, observed impacts, and team capacity. All WWA studies also consider how vulnerability, and exposure and response shape the impacts.

Climate Central is an independent group of scientists and communicators who research and report the facts about our changing climate and how it affects people's lives. Climate Central is a policy-neutral 501(c)(3) nonprofit.

INTRODUCTION

In 2015, after years of failed negotiations, the world celebrated a landmark achievement: the signing of the Paris Agreement. This historic accord set a global goal of “holding the increase in the global average temperature to well below 2°C above pre-industrial levels and pursuing efforts to limit the temperature increase to 1.5°C above pre-industrial levels, recognizing that this would significantly reduce the risks and impacts of climate change”.[1] Unlike its predecessor, the Kyoto Protocol, the Paris Agreement was ratified by nearly every country in the world, including the largest past and present emitters, establishing a legally binding framework to protect people and ecosystems from the dangers of unmitigated climate change.

In the Paris Agreement, countries are allowed to determine for themselves how much they will reduce their emissions, through what are known as Nationally Determined Contributions (NDCs), and to develop their adaptation plans. As stated in the agreement, “Each Party's successive nationally determined contribution will represent a progression beyond the Party's then current nationally determined contribution and reflect its highest possible ambition, reflecting its common but differentiated responsibilities and respective capabilities, in the light of different national circumstances”.[2]

Most countries have submitted and updated their NDCs over time, and some emission reductions have been achieved; however, a significant gap remains between current pledges and the emissions cuts required to limit global temperature rise to 1.5°C this century. Moreover, many countries are not on track to meet even their current pledges.

Last year, for the first time, the global mean temperature reached 1.5°C above pre-industrial levels over a full calendar year. The five-year average now stands at 1.35°C, and the estimated human contribution to warming was 1.36°C in 2024.[3] Meanwhile, fossil fuels continue to be burned at high rates, emissions are still rising rather than falling, impacts are escalating, and the world remains far from achieving net-zero emissions, the level necessary to stabilize temperatures at current levels.

At the time of the signing of the Paris Agreement in December 2015, global mean temperatures were 0.97°C above pre-industrial levels, as estimated with a five-year average. Temperatures have thus risen globally by more than 0.3°C, and the world has witnessed many record hot years. 2024 is the warmest year on record, with 2023 following closely behind. Every month in the past three years has set a new heat record, and rising temperatures have broken countless local records worldwide.

These are not just alarming numbers; they reflect a rapidly worsening global health crisis driven by climate change. Health risks linked to climate change are reaching unprecedented levels: heat-related deaths among people over 65 have increased by 167% since the 1990s, while exposure to extreme weather continues to rise. An estimated 16,600 people lost their lives across European cities during the summer of 2025 alone as a result of increased temperatures from the burning of fossil fuels. In Africa, heat waves continue to be a silent killer — climate change is driving rising temperatures faster than the global average, amplifying the health burden of heat.[5] Climate-sensitive diseases are spreading, and hundreds of millions of people now face growing food insecurity.

Despite these visible and escalating hazards and risks, governments and industries continue to invest in fossil fuels, with CO_2 emissions reaching an all-time high in 2023 and again in 2024.

Seeing these impacts at 1.35°C, in light of still-rising fossil fuel emissions and the most recent climate conferences being held in oil-producing countries, led Samoa to speak on behalf of the Alliance of Small Island States (AOSIS) at the COP28 in Dubai: "This COP has failed us...We have come to the conclusion that the course correction that is needed has not been secured. We have made incremental advancement over business as usual when what we really needed was an exponential change in our action".[6]

Despite the fact that global emissions are not decreasing and current NDCs remain insufficient to stabilize warming at 1.5°C, this does not mean that the Paris Agreement is a failure.

According to the 2024 Emissions Gap Report, with full implementation and continuation of current NDCs, global warming is projected to reach 2.6°C over this century, with more warming expected if NDCs are not fully implemented. When compared with what could be understood as the “business as usual” scenarios prior to the Paris Agreement, this warming level is significantly lower. In the 2015 Emissions Gap Report — published around the time the Paris Agreement was adopted — the “baseline” projected warming was about a 4°C global temperature increase.

Arguably, the fact that the latest Emissions Gap Report no longer includes a 4°C baseline is an achievement of the Paris Agreement and its subsequent implementation mechanisms, such as the regularly updated NDCs and the global stocktake.

In this report, we analyze heat conditions across past and future warming scenarios to show why the Paris goal of 1.5°C is crucial — and why aiming for the highest possible ambition in the upcoming NDCs, to be discussed at COP30 in Brazil in November, is essential for every country to achieve what the Paris Agreement set out in its preamble: "...taking action to address climate change, respect, promote and consider their respective obligations on human rights, the right to health, the rights of indigenous peoples, local communities, migrants, children, persons with disabilities and people in vulnerable situations and the right to development, as well as gender equality, empowerment of women and intergenerational equity".

ABOUT THE ANALYSIS

This report explores how heat experienced locally — through hot days and heat waves — is influenced by global warming. Heat contributes to an estimated 500,000 deaths worldwide each year, making it the deadliest form of extreme weather. The future frequency and intensity of this threat depends mostly on global carbon emissions levels in the coming decades, which the Paris Agreement goal aims to curb.

This analysis describes heat conditions at four levels of global warming compared with pre-industrial temperatures (Table 1).

Table 1.
Levels of global warming — above a pre-industrial baseline — used in this analysis

Global warming level	Description
1°C	Amount of warming that had occurred when the Paris Agreement was signed (2015)
1.3°C	Amount of warming that has occurred through the present day (2025)
2.6°C	Amount of warming *projected* by ~2100 if Paris Agreement emissions reduction pledges are fully carried out (and if enabling policies are enacted and sustained)
4°C	Amount of warming that *was* employed as the baseline warming expected by ~2100 in the 2015 emissions gap report, prior to the signing of the Paris Agreement

Notes: See Methodology for further explanations of these global warming levels and their sources.

Using these global warming levels, we performed three analyses, focusing on the frequency of hot days and the intensity of individual heat events across six continents.

1. **Hot days pre- and post-Paris Agreement:** We compared the number of hot days* in each location in our dataset (207 countries, territories, and dependencies — referred to as "countries" in the rest of the report for simplicity) during the decade leading up to the signing of the agreement

(2005-2014) and during the decade after (2015-2024).

2. **Future hot days with and without the Paris Agreement:** To determine how effective the Paris Agreement has been at curbing future heat, we used climate models to calculate the number of hot days in each country if the planet warms to 2.6°C above the pre-industrial average, which is the amount of warming projected by ~2100 given countries' current pledges to reduce heat-trapping emissions. We then did the same for a world with 4°C of warming, or what was expected before the agreement was signed.

3. **Case studies: extreme heat events under historical and future warming conditions:** We selected six severely impactful recent extreme heat events around the world and determined the change in likelihood and intensity of these events under the four warming scenarios listed in Table 1.

*Note: "Hot days" refer to days with temperatures warmer than 90% of temperatures observed at that site over the 1991-2020 period (also referred to as temperatures above the 90th percentile). These are days with temperatures that people would consider hot based on their local experience.

RESULTS: GLOBAL OVERVIEW

A 0.3°C rise drove a surge in hot days: 1°C vs. 1.3°C

Compared with the decade before the Paris Agreement, nearly every country has seen an increase in the number of hot days (Figure 1).

Key findings:

1. On average, during the last decade (2015-2024), countries around the world have experienced 11 more hot days per year than in the decade before the Paris Agreement (2005-2014).
2. In 10 countries, the 0.3°C of warming since 2015 has resulted in an average of at least 30 more hot days annually.
3. Of 207 countries, 101 have experienced an average of at least 10 additional hot days annually.

See Table 2 for a list of the countries or territories from each continent with the largest increases in hot days, or **download the data** for all 207 countries.

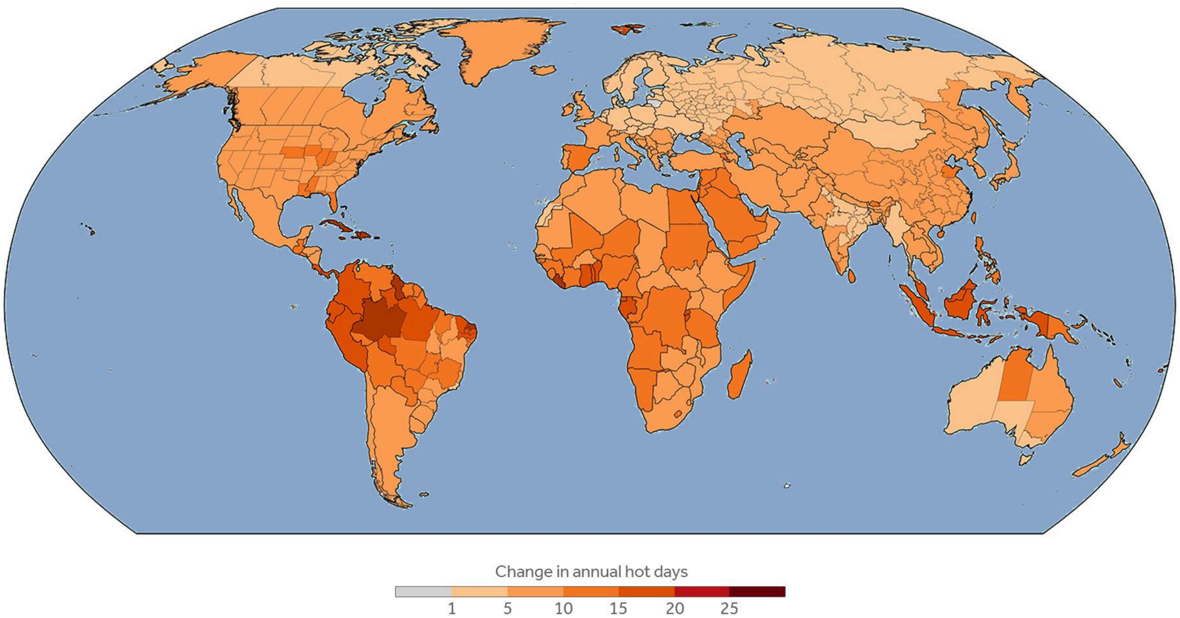

Figure 1. Change in the number of hot days per year in each country between the decade leading up to the Paris Agreement (2005-2014) and the decade since (2015-2024).

Climate pledges could lead to a safer future: 2.6°C vs. 4°C

Two things are clear when comparing the future of hot days in a world with 2.6°C of warming (projected if countries fully implement their current pledges to reduce heat-trapping emissions) to a world with 4°C of warming (which was expected before the Paris Agreement was signed). First, current pledges are not enough to prevent a significant increase in the frequency of hot days compared with today. Second, if fully implemented and supported by sustained policies, the pledges made to date would lead to far fewer hot days than the planet would face under the pre-Paris warming projections (Figure 2).

Key findings:

1. In a 2.6°C world, countries would experience an average of 57 additional hot days per year than they do in today's climate.
2. In a 4°C world, that increase would be even larger: countries around the world would experience an average of 114 additional hot days per year compared with today.
3. For nearly 30 countries, the reduction in projected warming from 4°C to 2.6°C would result in at least 100 fewer hot days per year, on average.

See Table 3 for the countries or territories from each continent with the largest increases in hot days if the planet warms to 2.6°C above pre-industrial levels, or **download the data** for all 207 countries and territories.

Table 2.

Top countries per continent with the largest increase in hot days since the Paris Agreement

Country	Continent	Hot days per year (2005-2014)	Hot days per year (2015-2024)	Increase in annual average hot days
Comoros	Africa	49 (41, 57)	72 (66, 78)	23 (18, 28)
Equatorial Guinea	Africa	58 (52, 64)	77 (73, 81)	19 (15, 23)
Indonesia	Asia	45 (38, 52)	63 (56, 70)	18 (14, 22)
Malaysia	Asia	36 (29, 43)	53 (47, 59)	17 (13, 21)
Svalbard and Jan Mayen Islands	Europe	43 (36, 50)	62 (50, 74)	19 (11, 27)
Andorra	Europe	44 (41, 47)	55 (51, 59)	11 (9, 13)
St. Vincent and the Grenadines	North America	82 (70, 94)	117 (106, 128)	35 (28, 42)
Panama	North America	45 (38, 52)	64 (60, 68)	19 (15, 23)
Kiribati	Oceania	99 (80, 118)	134 (123, 145)	35 (23, 47)
Australia	Oceania	37 (35, 39)	42 (41, 43)	5 (4, 6)
Falkland Islands	South America	29 (27, 31)	33 (31, 35)	4 (3, 5)
Guyana	South America	66 (58, 74)	87 (78, 96)	21 (16, 26)

Notes: *For each continent, we chose the island country and the mainland country with the largest increase in hot days (days when maximum temperatures are hotter than 90% of local historic temperatures) per year since the signing of the Paris Agreement. Data reflect a multi-model mean across 21 CMIP6 models; ranges in parentheses reflect the upper and lower bounds of the 95% confidence interval.*

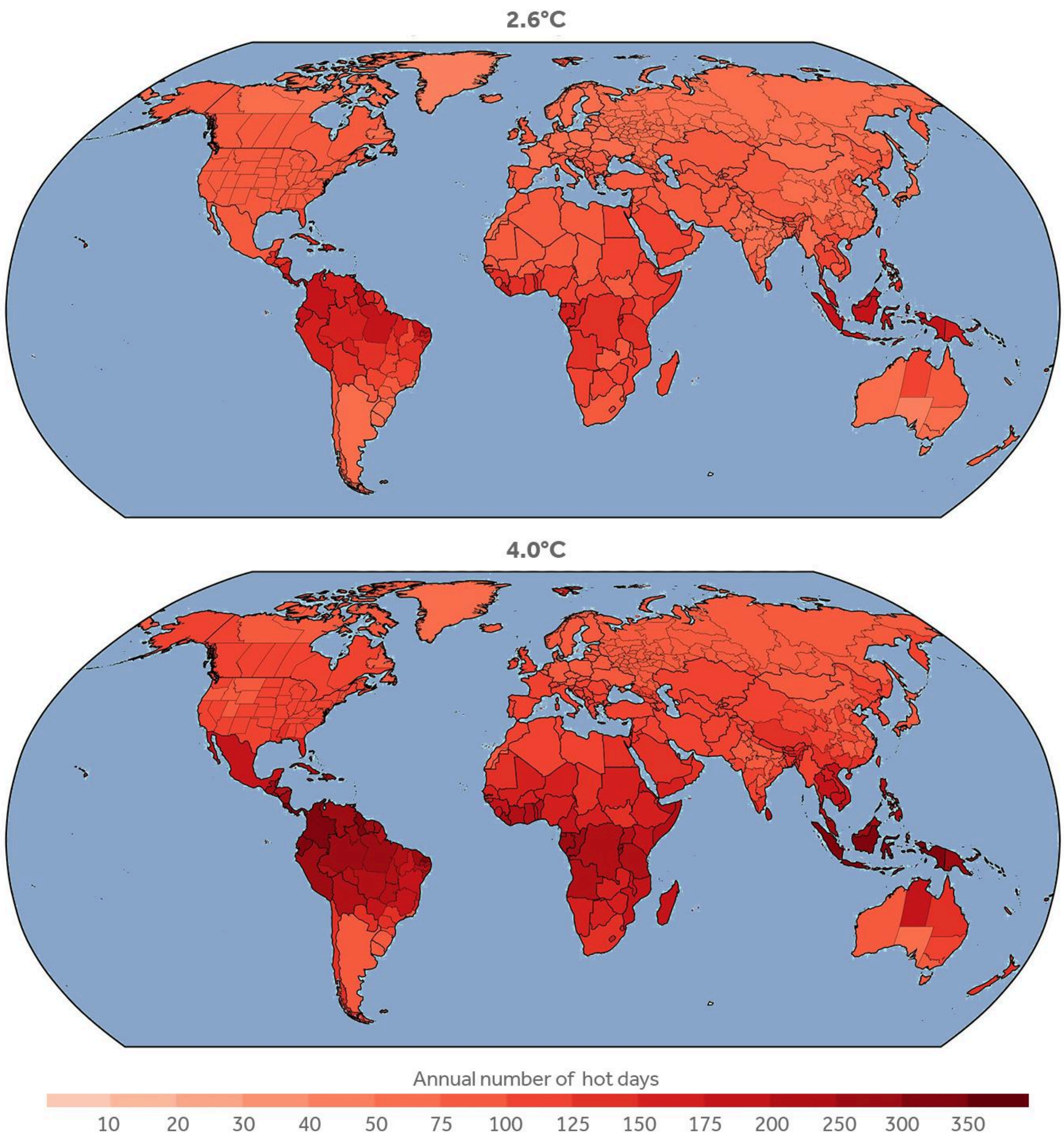

Figure 2. Number of hot days per year in each country for global warming levels of 2.6°C and 4.0°C above pre-industrial temperatures.

Table 3.

Top countries per continent with the largest increase in hot days at global warming levels of 2.6°C and 4°C

Country	Continent	Increase in hot days per year with global warming level of 2.6°C	Increase in hot days per year with global warming level of 4.0°C
Seychelles	Africa	137 (127, 147)	262 (247, 277)
Burundi	Africa	109 (97, 121)	210 (196, 224)
Indonesia	Asia	134 (126, 142)	248 (238, 258)
Malaysia	Asia	125 (115, 135)	243 (231, 255)
Svalbard and Jan Mayen Islands	Europe	49 (40, 58)	100 (86, 114)
Albania	Europe	32 (30, 34)	63 (60, 66)
Saint Lucia	North America	152 (145, 159)	256 (248, 264)
Panama	North America	147 (136, 158)	260 (244, 276)
Solomon Islands	Oceania	199 (193, 205)	271 (261, 281)
Australia	Oceania	25 (23, 27)	59 (57, 61)
Falkland Islands	South America	21 (19, 23)	46 (44, 48)
Guyana	South America	130 (121, 139)	242 (230, 254)

***Notes:** For each continent, we chose the island country and the mainland country with the largest increase in hot days (days when maximum temperatures are hotter than 90% of local historic temperatures) per year if the planet warms to 2.6°C above pre-industrial levels, and if the planet warms to 4.0°C. Data reflect a multi-model mean across 21 CMIP6 models; ranges in parentheses reflect the upper and lower bounds of the 95% confidence interval around the mean.*

RESULTS: CASE STUDIES

Need greater ambition to avoid extreme events and impacts

In order to better understand the impact of heat under different global warming scenarios, we selected one particularly impactful extreme heat event from each of the six major continents as case studies (Table 4). We determined how much climate change has increased the intensity and likelihood of events like these — both under 1°C of global warming (the average global temperature increase in 2015) and under 1.3°C (today's average global temperature increase). We then determined how much more likely and more intense these events would become under 2.6°C and 4°C of warming above pre-industrial temperatures (Figure 3, Tables 5a, and 5b).

Table 4.
The six heat events analyzed, event definitions, and notable impacts

Region	Year	Event definition	Notable impacts
Mexico and Southwestern U.S.	2024	5-day average of maximum daily temperatures in May and June	• *Temperature records broken* • *Exacerbated existing drought impacts* • *125+ deaths*
Southern Europe	2023	7-day average of maximum daily temperatures annually	• *Temperature records broken* • *Heat-related deaths* • *Power demand spikes* • *Crops negatively impacted*
Amazon River Basin	2023	Average daily temperature from June to November	• *Hottest dry season on record* • *Heat-driven drought* • *200+ freshwater dolphins killed* • *Widespread hydroelectric power cuts*
India and Pakistan	2022	Average maximum daily temperature from March to April	• *90+ heat-related deaths* • *Glacial-lake outburst flood* • *Forest fires* • *Reduced wheat yields* • *Power shortages*
Southeastern Australia	2019	7-day maximum temperature annually	• *Temperature records broken* • *Catastrophic wildfires* • *100s millions vertebrate deaths* • *400+ smoke inhalation deaths*
Burkina Faso and Mali	2024	5-day maximum temperature in April	• *Elevated hospitalisations and deaths* • *High overnight temperatures*

The intensity, likelihood, and risks for heat events at each warming level

The findings for each region emphasize how even small increases in global temperature can push vulnerable communities and ecosystems closer to, or beyond, the limits of adaptation.

These summaries compare current outcomes to a modeled scenario in which the Paris Agreement had not been implemented, highlighting the substantial benefits already achieved in terms of lives saved, livelihoods protected, and ecosystems preserved. At the same time, the results underscore how much work remains and the urgency of continued climate action.

1. Mexico and Southwestern U.S.: Since the Paris Agreement, a heat event like the one in 2024 has become 86% more likely and about 0.3°C hotter. Under the 2.6°C warming expected, if current emissions reduction pledges are met, events this rare are expected to become an additional 1.7°C hotter. With the 4°C of warming that was expected before the Paris Agreement, such events would be 3.5°C hotter than what was observed in 2024. The event highlighted disparities in preparedness, with strong planning in parts of the U.S. but limited heat governance systems in Central America. Urban heat islands amplified impacts of heatwaves and informal settlements faced increased health and livelihood risks.

2. Southern Europe: Southern Europe's hottest week of the year is warming at about twice the global average. A weeklong heat wave like the one in 2023 is now 70% more likely and 0.6°C hotter than a decade ago. Such events were nearly impossible in the pre-industrial climate. If current emissions targets are met, similar heat waves could be 3°C hotter in a 2.6°C world; in a 4°C climate, they would be 6°C hotter than today. In the 2.6°C scenario, extreme heat events as hot as in 2023 would occur almost every year. In the 4°C scenario, such events would also be expected every year, but would be much hotter on average. The event shows how early-season heatwaves sharply increase mortality risks, especially for older adults, outdoor workers, and people in precarious housing conditions. Although Spain and Portugal's heat plans have reduced deaths, limited preparedness in North Africa still leaves millions dangerously exposed.

3. Amazon River Basin: Before human-caused climate change, a dry season as hot as the one in 2023 was virtually impossible. Today, the region is warming about 1.4 times faster than the global average, and similar events now occur roughly once every 10 years. Since the Paris Agreement signing in 2015, the likelihood of such events has increased tenfold, and events of comparable rarity are about 0.4°C hotter than in 2015. If global warming is limited to 2.6°C instead of 4°C, future events would still be 1.7°C hotter than today, but about 2°C cooler than they otherwise would have been. In both 2.6°C and 4°C scenarios, dry seasons as severe as 2023 are expected nearly every year. The 2023 drought that was severely exacerbated by the heat, revealed the acute vulnerability of smallholder farmers, Indigenous Peoples, and riverine communities as water-based livelihoods such as agriculture and fishing were severely disrupted. Strengthening resilience across the basin requires systemic adaptation in land, and water governance systems.

4. India and Pakistan: Due to human-induced climate change, high pre-monsoon season temperatures like those seen in 2022 are now about 30 times more likely and 2.1°C higher than they would have been without human influence. Over the past decade, such events have become 0.3°C hotter and about twice as likely. Under current national emission reduction plans (a 2.6°C path) these events would be roughly 1.4°C hotter and seven times more likely. Without emissions reductions (a 4°C path), a 2022-like spring would be expected every two years, about 14 times more likely and 3.3°C hotter than today. Despite this growing risk, most of India's 37 heat action plans take an overly simplified view of heat waves, often neglecting the needs of vulnerable groups and placing limited emphasis on systemic change, equity, and social protection.

5. Southeastern Australia: Due to climate change, seven-day heat events like the one that drove devastating bushfires in 2019 are now about 2.5 times more likely and 0.9°C hotter than they would have been without human influence. Over the past decade, the likelihood of such events has increased by 38%. Under the current national emissions reduction plans limiting warming to 2.6°C instead of 4°C, future events of this rarity are expected to be about 1.5°C cooler than they would be otherwise, though still around 1.4°C hotter than if they occurred today. The signal in southeastern Australia is weaker than in the other regions, highlighting that natural variability is still an important driver of local temperatures, even in a rapidly warming world. The 2019-2020 bushfires show that strong preparedness and emergency systems can reduce harm, but also reveal the limits of resilience, especially for vulnerable communities.

6. Burkina Faso and Mali: The extreme five-day heat observed in the Sahel in early April 2024 would have been impossible without human-induced climate change. Compared to pre-industrial conditions, the event was around 2°C hotter than if it occurred today. Since the signing of the Paris Agreement, about 0.5°C has been added to the intensity of such heat events. Under current national emissions reduction plans, limiting warming to 2.6°C instead of 4°C, future events of this rarity would be about 1.8°C cooler than they would otherwise be, though still about 1.7°C hotter than today. These heat events are already no longer rare and would be considered relatively cool in a 4°C world. However, gaps in adaptation financing continue to undermine resilience, particularly in countries like Mali and Burkina Faso, where aging electricity infrastructure contributed to major power outages during the 2024 heat wave.

The overarching message is consistent across regions: extreme heat events are becoming hotter and more frequent globally. The visualization of results in Figure 3 illustrates that regional differences and natural variability remain important factors in the extent to which the intensity of extreme heat events increases.

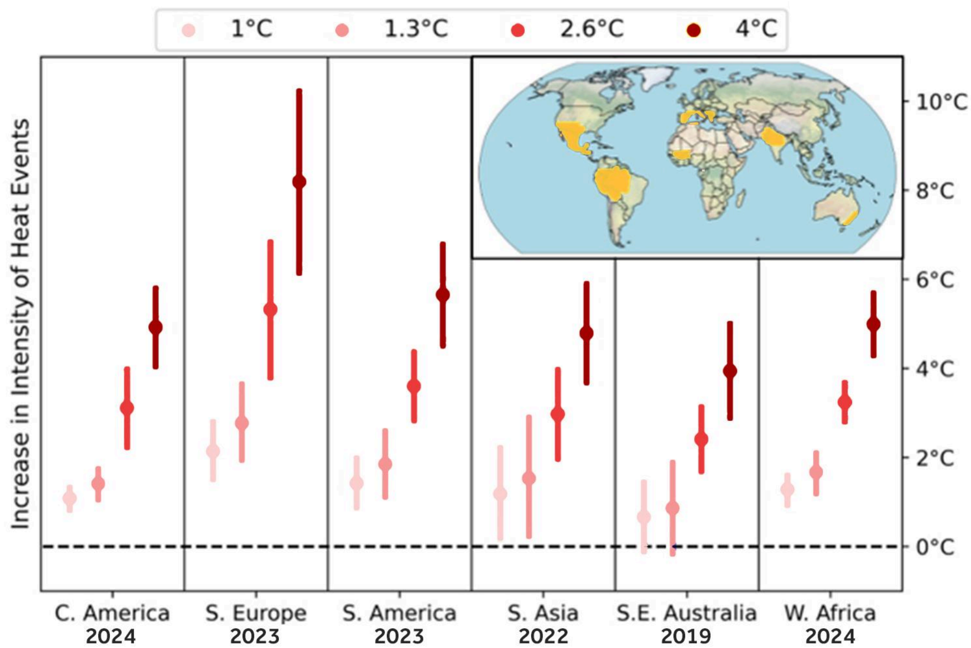

Figure 3. The increase in intensity of the example heat events included in this study. The dots represent the best estimate and the bars the 95% confidence interval. The geographical extent of the events studied in this analysis are shown in yellow on the map, from left to right: Mexico and Southwestern U.S.; Amazon River Basin; Burkina Faso and Mali; Southern Europe; India and Pakistan; Southeastern Australia

Interpreting tables 5a and 5b

Below, Table 5a shows the probability ratios of each heat event — in other words, how many times more or less likely a hot event is to occur. For example, the Mexico and Southwestern U.S. heat wave of 2024 is about 28 times more likely today than before human-caused global warming. It is about 1.9 times more likely to occur today than it was in 2015. The same event would also be about 4.3 times more likely with 2.6°C of global warming compared to today, and about 5.9 times more likely with 4.0°C global warming.

Using the probability of the event in 2025 (1.3°C), Table 5b shows the difference in temperature of an event that rare in different climates. For example, the India and Pakistan spring heat of 2022 is expected once every 30 years in 2025. A 1-in-30 year event would be 1.5°C and 0.4°C cooler in the pre-industrial and 2015 climates respectively, and 1.4°C and 3.3°C hotter at the 2.6°C and 4°C global warming levels respectively.

Table 5a.
Change in likelihood of recent extreme heat events with different amounts of global warming

Event	Probability Ratio			
	PI to 1.3°C	1°C to 1.3°C	1.3°C to 2.6°C	1.3°C to 4.0°C
Mexico and Southwestern U.S.	**28** (8.2, 110)	**1.9** (1.5, 2.3)	**4.3** (2.9, 6.6)	**5.9** (3.2, 11)
Southern Europe	∞	**1.7** (1.4, 2.7)	**2.6** (1.5, 4.5)	†
Amazon River Basin	∞ (7.7, ∞)	**9.5** (2.0, 67)	†	†
India and Pakistan	**34** (1.1, 2800)	**2.1** (1.1, 4.0)	**6.5** (2.2, 19)	**14** (3, 70)
Southeastern Australia	**4.2** (0.56, 31)	**1.4** (0.89, 2.0)	**4.4** (2.7, 7.9)	**14** (6.4, 32)
Burkina Faso and Mali	∞	**8.6** (0.01, 8400)	**34** (6.5, 760)	**76** (20, 1400)

Notes: Values refer to "times more likely to occur" when comparing each warming scenario in the column header. PI refers to the pre-industrial climate. Best estimates are shown in bold with the 95% confidence interval upper and lower bounds provided in parentheses below.
∞ = *The event would have been virtually impossible without human-induced climate change.*
† = *Events like this are projected to happen virtually every year at this warming level. The heat would become so common that statistical measures of likelihood break down — what used to be considered an extreme event would instead count as a cool year.*

Table 5b.
Change in intensity of recent extreme heat events with different amounts of global warming

Event	Increase in Temperature (°C)			
	PI to 1.3°C	1°C to 1.3°C	1.3°C to 2.6°C	1.3°C to 4.0°C
Mexico and Southwestern U.S.	**1.4** (1.0, 1.8)	**0.3** (0.2, 0.4)	**1.7** (1.1, 2.0)	**3.5** (2.7, 4.0)
Southern Europe	**2.8** (1.9, 3.7)	**0.6** (0.4, 0.9)	**3.1** (1.9, 3.5)	**5.9** (4.1, 6.9)
Amazon River Basin	**1.9** (1.0, 2.7)	**0.4** (0.2, 0.6)	**1.7** (1.4, 2.2)	**3.8** (3.0, 4.6)
India and Pakistan	**1.5** (0.2, 3.0)	**0.4** (0.0, 0.7)	**1.4** (1.0, 2.0)	**3.3** (2.4, 4.0)
Southeastern Australia	**0.9** (-0.2, 1.9)	**0.2** (-0.1, 0.4)	**1.4** (0.8, 1.6)	**3.0** (1.9, 3.4)
Burkina Faso and Mali	**1.7** (1.1, 2.2)	**0.4** (0.3, 0.5)	**1.6** (1.4, 1.9)	**3.3** (2.9, 3.9)

Notes: Values refer to the temperature increase of the heat event as defined in Table 4 when comparing each warming scenario in the column header. PI refers to the pre-industrial climate. Best estimates are shown in bold with the 95% confidence interval upper and lower bounds provided in parentheses below.

Key findings:

1. With 0.3°C of warming since the Paris Agreement was signed in 2015, all six of the extreme heat events studied have substantially increased in likelihood and intensity — global warming over the last ten years increased the likelihood by 1.4-9.5 times and the intensity by 0.2-0.6°C.
2. Three of the six extreme events studied would have been nearly impossible without climate change. This was seen for both seasonal heat (Amazon River Basin) and short heat waves (Southern Europe, Burkina Faso and Mali).
3. The 4°C of global warming that was projected before the signing of the Paris Agreement would have resulted in a very strong increase in the likelihood and intensity of extreme heat — each event would be 3-6°C hotter than in the present climate. All of the events analyzed would be commonplace in a 4°C climate.
4. With 2.6°C of warming, these events would be 1.5-3°C hotter than in the present climate. While this is a substantial improvement from the 4°C scenario, events that were already highly impactful on people and ecosystems would be intolerably more severe in a 2.6°C world.

While current pledges limiting warming to 2.6°C offer improvements over a 4°C future, they still lead to dangerously hotter, more frequent heat waves, far above what our societies are able to adapt to. The highest possible ambition, as set out in the Paris Agreement, is urgently needed. Modeled mitigation pathways that limit warming to 1.5°C and 2°C involve deep, rapid, and sustained emissions reductions.

Heat action in the Paris decade, and what's needed for the future

Adaptation at a glance

Ten years ago, the Paris Agreement marked a turning point in the global response to climate change. By uniting nearly every nation behind a shared framework for action, it signaled that the world was serious about avoiding the most dangerous levels of warming and accelerating adaptation efforts. Since 2015, there has been rapid growth in renewable energy as the costs of solar and wind power have declined, and the number of net-zero commitments has risen. At the same time, fossil fuel use remains high, and global emissions have not yet peaked. Since 2015, national adaptation plans (NAPs) have multiplied (Figure 4), early warning systems (EWS) have expanded and improved preparedness, and climate risks are being factored into long-term planning across many sectors.

Yet progress has not kept pace with escalating risks; finance and implementation remain insufficient and uneven, and vulnerable communities are still dangerously exposed, particularly to extreme heat, the deadliest extreme weather hazard.

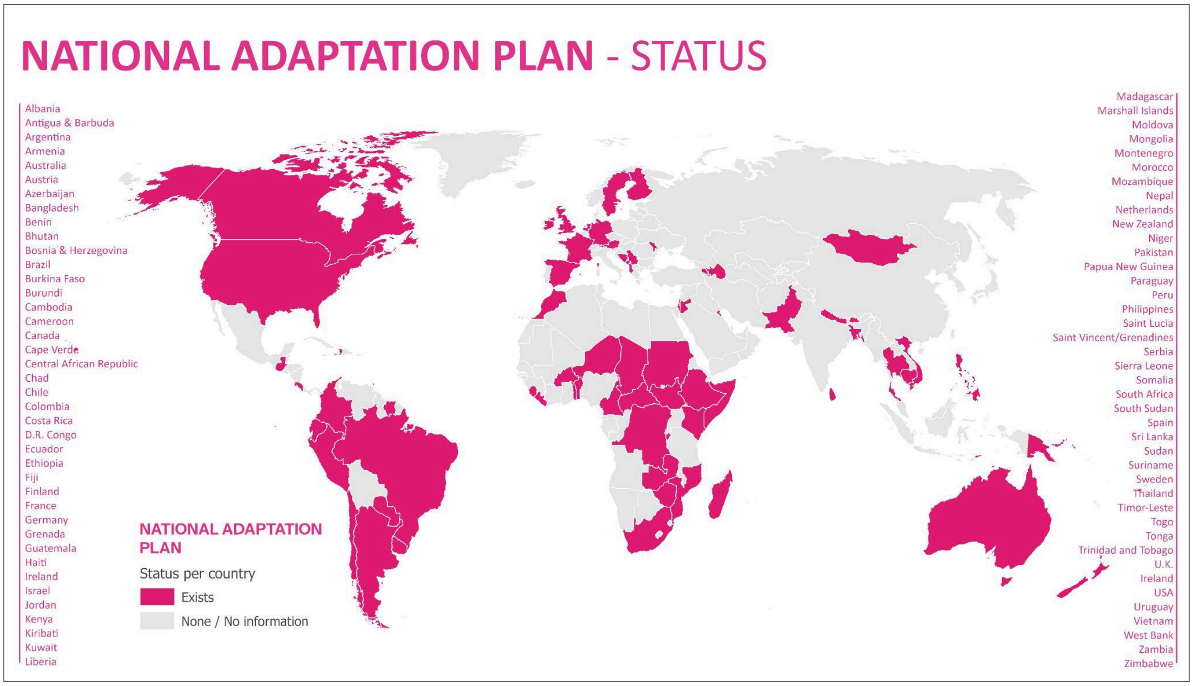

Figure 4. Status of National Adaptation Plans (NAPs) per country as of October 2025. Disclaimer: this list is not exhaustive. Data is from UNFCCC (2025a); UNFCCC (2025b); *World Administrative Boundaries: WFP (2019)*. Disclaimer: data presented may not cover all countries.

Heat on the global agenda: progress and stagnation

Over the past decade, extreme heat has gained unprecedented visibility on the global stage. In 2016, the Global Heat Health Information Network (GHHIN) was established by the World Meteorological Organization (WMO), World Health Organization (WHO), and National Oceanic and Atmospheric Administration (NOAA) to accelerate heat action across research, policy, and implementation.[7] In 2022, the Red Cross Red Crescent launched an annual Global Heat Action Day to raise public awareness about heat risks.[8] In 2024, the UN Secretary-General's Call to Action on Extreme Heat formally recognized heat as a central climate and development challenge for the protection of vulnerable groups and workers.[9] Public concern has also grown; although people worldwide increasingly perceive extreme heat as a high risk, many still underestimate the health dangers, normalize unsafe exposure, or fail to link rising heat to climate change.[10]

Despite increased awareness and frameworks, progress remains uneven. Knowledge gaps, limited monitoring systems, and political instability have slowed policy development and undermined effective implementation.[11] Extreme heat remains an underreported and unrecognized disaster in some parts of the world due to definitional issues, legal framework gaps, surveillance gaps, dispersed data reporting responsibilities, and climatological differences.[12] Heat adaptation continues to lag in practice, particularly in finance, governance, and long-term measures. At the same time, political divisions, economic pressures, and shifting priorities are eroding climate ambition more generally. Meanwhile, research on heat risk is rapidly expanding,[13] but it is fragmented geographically and incomplete, with health, labor, and infrastructure data limiting the ability of decision-makers to design robust policies.[14]

With limited physiological tolerance, unequal access to cooling, and structural inequalities that amplify vulnerability, adaptation to heat is notoriously challenging. The coming decade demands both deeper emissions cuts and a rapid scale-up of adaptation to ensure communities can thrive in a hotter world.

Progress in early warning and early action

Heat early warning systems (HEWS) and heat-health/heat action plans (HHAPs/HAPs) are proven, cost-effective interventions for saving lives during acute heat events.[15] Linking health-informed meteorological alerts to preparedness and response measures provides critical information to raise awareness and trigger protective action, from opening cooling centers to mobilizing health services to triggering occupational safety measures.

Since the late 1990s, warning systems and heat action plans have expanded worldwide.[16] This especially accelerated in 2003 in Europe and 2010 in South Asia, following two respective extreme heat events. Today, around half of the countries worldwide (104) have extreme heat warnings, and at least 47 countries have national HHAPs (Figures 5, 6), though coverage remains uneven, with far fewer warning systems in Africa, Latin America, and parts of Asia.[17] Over the years, countries have also started shifting toward impact- and health-based warning approaches: Senegal and Burkina Faso developed pioneering African heat-health warning bulletins in 2015, Japan launched its HeatStroke Alert in 2020, and the U.K. shifted to an impact-based Heat-Health Alert in 2023.[18]

Despite this progress, major gaps remain in both quality and coverage. Only about half of weather services issue extreme temperature warnings, and not enough HEWS incorporate differential health impacts,[19] yet scaling up robust, health-based systems could prevent nearly 100,000 deaths annually.[20] When both plans and warning systems are in place, reviews highlight that they often remain short-term and largely health-focused, with limited integration into urban planning, labor protection, infrastructure, or social policy.[21] Population-level warnings are often too broad or generic, failing to target or reach the most vulnerable individuals.[22] Few plans address maternal, newborn, and child health risks, and monitoring mechanisms are generally weak.[23]

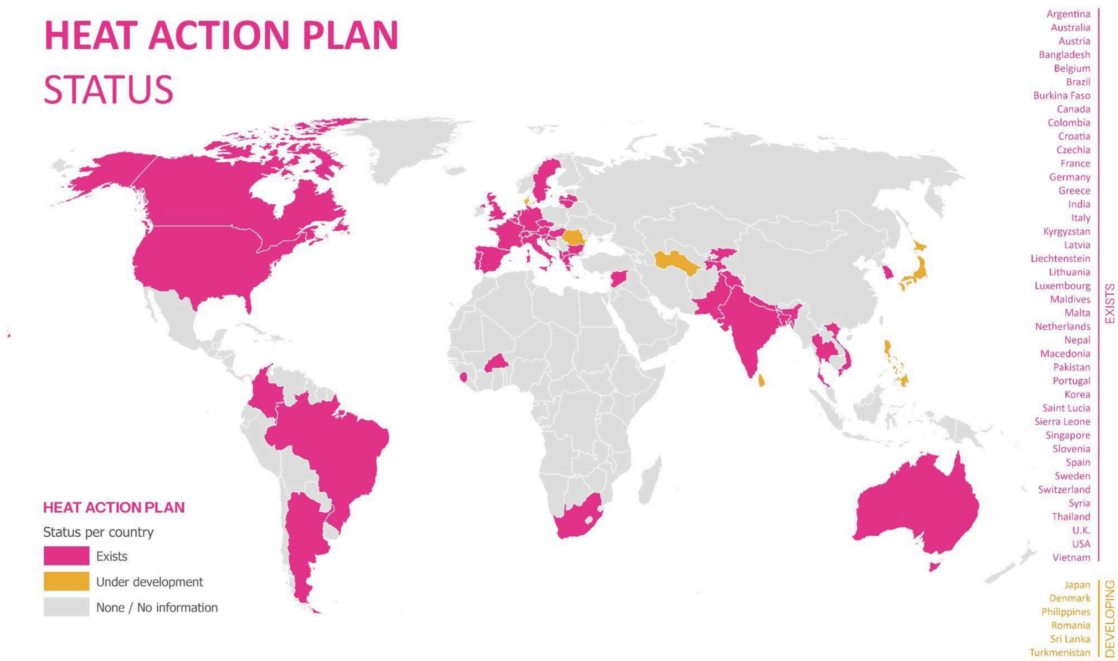

Figure 5. This map shows the type of national, sub-national, and city-level Heat Action Plans (HAPs) per country as of October 2025. Early Action Protocols (EAPs) were included as HAPs on the national level. See full list of data sources in the endnotes.[24] Disclaimer: data presented may not cover all countries.

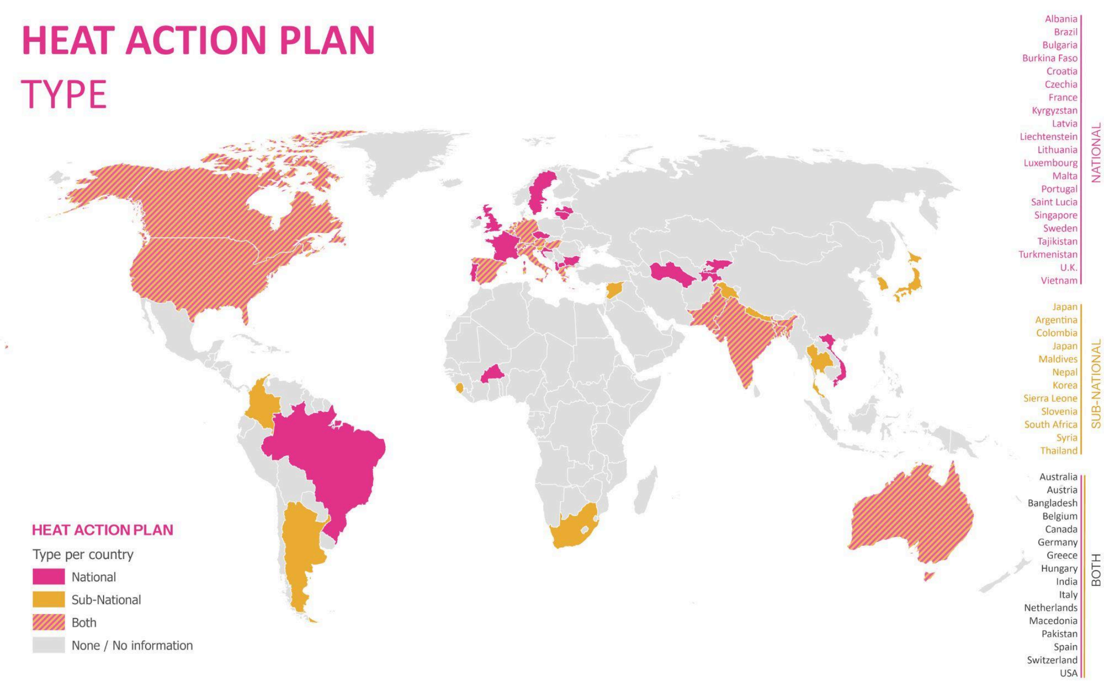

Figure 6. This map shows the type of national, sub-national, and city-level HAPs per country as of October 2025. Early Action Protocols (EAPs) were included as HAPs on the national level. See full list of data sources in the endnotes.[25] Disclaimer: data presented may not cover all countries.

Finally, while warning systems and action plans are typically designed for episodic events, many tropical and subtropical regions experience seasonal or even chronic extreme heat throughout the year.[26] Scaling up and improving existing HEWS and HHAPs, while broadening them across sectors and timescales, will be essential to reducing exposure and vulnerability.

The need for transformative adaptation in a hotter world

Transformative adaptation to extreme heat requires moving beyond short-term interventions to address root causes and structural risk drivers. This means strengthening critical systems such as water, energy, and health care, which largely remain inadequately prepared for escalating extremes and face access inequities.

Urban planning must be reconfigured to reduce exposure and vulnerability through measures like climate-resilient housing, redesigned public spaces, and accessible public transport systems that integrate cooling and shading. Rising temperatures are expected to impact food security in some of the most vulnerable regions of the world.[27] Disaggregated data on gender, age, and disability remain largely absent from adaptation finance and national plans, even though women face higher mortality risks during heatwaves, and densely populated areas such as informal settlements house some of the most vulnerable populations.[28] Equity and inclusion issues must be addressed in adaptation policies. The inclusion of local knowledge, citizen science, and bottom-up approaches in heat adaptation is also essential and effectively improves heat literacy and reduces heat-related symptoms.[29]

Finally, advancing multi-hazard solutions with co-benefits — such as urban greening that reduces both heat and flooding, or labor protections that safeguard health and productivity — offers a pathway for truly transformative adaptation, but these approaches are still underdeveloped and unevenly implemented.

Scaled action for enduring protection

Extreme heat has rapidly risen on the global agenda, yet responses remain uneven, fragmented, and underfunded across regions and populations to match the pace and scale of rising climate risks. Early warning systems and heat action plans have saved lives and need to be further expanded, but they cannot alone meet the scale of rising risks. Deeper shifts are needed, including: strengthening systemic risk thinking; establishing occupational safety laws; rethinking urban design; recognizing heat in national disaster laws; and utilizing social protection systems to ensure that the most vulnerable are protected. Delivering these solutions while embedding equity considerations throughout will be essential to safeguard lives and livelihoods in an increasingly hotter world.

Summary

1. Over the past decade, extreme heat has gained unprecedented recognition both through the rising temperatures people are experiencing and global initiatives set up to respond to them.
2. Extreme heat is too often an underrecognized disaster, putting communities at risk, because of gaps in definitions, legal frameworks, and impact data.
3. Costs of inaction are rising faster than progress on adaptation. Extreme heat is compounding risks, straining health, labor, livelihoods, and infrastructure systems, while adaptation finance remains insufficient, particularly for the groups most at risk.
4. Heat early warning systems and heat action plans have expanded worldwide and proven cost-effective, especially when delivered together. But much work remains to implement these solutions in the parts of the world at highest risk.
5. Disaggregated data and intentional inclusion of gender, age, disability, and local knowledge are needed in adaptation efforts to avoid maladaptation.
6. Transformative, multi-benefit solutions exist in literature but are rarely implemented, such as urban greening, labor protections, climate-resilient housing, and access to healthcare. These solutions can deliver co-benefits across hazards, yet they remain underdeveloped and unevenly implemented.
7. Adaptation and resilience efforts will ultimately become ineffective without a rapid and sustained shift away from fossil fuels, as the limits of adaptation are being reached.

METHODOLOGY

Defining global warming levels

The two observed global warming levels analyzed in this report — 1.0°C and 1.3°C — were defined based on five-year temperature averages reported by the Copernicus Climate Change Service. In December 2015, when the Paris Agreement was signed, global mean temperatures stood at 0.97°C above pre-industrial temperatures. By December 2024, the global mean temperature had risen by 1.35°C above pre-industrial temperatures. We round these estimates to 1.0°C and 1.3°C, respectively.

The two projected global warming levels analyzed in this report — 2.6°C and 4.0°C — are derived from the UN Emissions Gap Reports of 2015 and 2024. The 2015 report, published around the time the Paris Agreement was adopted, reported a “baseline” projected warming of about 4°C. The 2024 report projected a warming of between

2.6°C and 3.1°C, given current nationally determined contributions and associated national policies.

Calculating the frequency of "hot days"

To calculate the frequency of "hot days," ERA5 data were first used to calculate the 90th percentile temperature of all maximum daily temperatures at each grid cell over the 1991-2020 time period. We then used the World Bank's Climate Change Knowledge Portal to access 21 ERA5-debiased CMIP6 models, from which we computed a multi-model average of the number of days above the 90th percentile for each modeled year from 1950-2100.

Because CMIP6 models warm at different rates, global warming levels were identified separately for each model. To do so, we computed increases in global mean temperatures for each model relative to their 1950-1959 baseline, before adjusting this warming by a common factor of 0.22°C (the estimated observed warming from the pre-industrial period to 1950). For each model, we then identified the 10-year period for when global mean temperature had increased by 1.0°C, 1.3°C, 2.6°C, and 4.0°C. We then used the appropriate 10-year period for each model to calculate the mean number of hot days per year and took a multi-model mean.

To calculate country-level averages, we took the final number of days above the 90th percentile and averaged them across each country, weighted by population density in each ERA5 grid cell.

WWA heat event criteria

The six event case studies featured in the report were identified using WWA criteria. In order for scientists at WWA to consider conducting a study on an extreme heat event, it must meet one of these two criteria:

1. Record-breaking or unseasonably high temperatures over a large geographic area, for a prolonged period (3+ days), are either forecasted or observed in global data products.
2. Media reports of ≥10 heat-related deaths or major disruptions to critical sectors (notably transportation, energy, and manufacturing) are found.

It must also meet at least one of these:

3. The heat identified is occurring during the first 3-6 weeks of the hot season (due to heightened vulnerability of early-season extreme temperatures).
4. The heat is occurring in a densely populated area (≥200 people/km^2).
5. The heat is occurring in a highly vulnerable area (using ≥4.8 on the INFORM index as an indicator) and/or one with a high lack of coping capacity (≥6.0 INFORM).

Once an event is triggered, the WWA team then decides whether to undertake an attribution study. Apart from team capacity, providing studies in understudied regions, such as South Sudan or Central Asia, is a key criterion to undertake a detailed WWA study, following the methodology described here.

WWA attribution method

Methods for observational and model analysis and for model evaluation and synthesis are used according to the World Weather Attribution Protocol.[30]

Summary of the protocol:

1. Attribution of the event from observations (including station and reanalysis data).
2. Validation of the climate models. Climate models are rejected if their geospatial pattern, seasonal cycle, or fit parameters to the event distribution have a strong difference with any observed dataset.
3. Attribution of the event from climate models (including station and reanalysis data).
4. Synthesis of observations and models into a single attribution statement.

The attribution of observed and climate model data is done on an annual timeseries of the event in each dataset. For each time series, we estimate the parameters of a statistical model in which the index depends on the GMST. This model is then used to estimate the return period and intensity of the event under study for the 2025 GMST and for a 1.3°C cooler counterfactual climate: this allows us to compare the expected intensity and frequency of similar events now and in the pre-industrial past (1850-1900, based on the Global Warming Index), by calculating the probability ratio and change in intensity of the event.

A nonstationary normal (India and Pakistan; Southeastern Australia; the Amazon River Basin) or GEV (Burkina Faso and Mali; Southern Europe; Mexico and Southwestern U.S.) distribution was used to model the events considered in this study. The distribution is assumed to shift linearly with the covariates, while the variance remains constant. The parameters of the statistical model are estimated using maximum likelihood. The region definitions of each event are shown in Figure 3.

Endnotes

1. Paris Agreement, article 2, 2015
2. Paris Agreement, article 4, 2015
3. Forster et al., 2025
4. Vautard et al., 2024
5. WMO, 2024; Scovronick, 2018
6. Piester, 2024
7. GHHIN, n.d.
8. IFRC, 2025
9. UN, 2024
10. Climate Centre, 2025
11. Wang et al., 2025
12. Harrington & Otto, 2020; Ebi et al., 2021; The Lancet, 2021
13. Brogno et al., 2025
14. Ebi et al., 2021
15. Hess & Ebi, 2015; Toloo et al., 2013; Williams et al., 2022
16. Pereira Marghidan et al., 2025; McGregor et al., 2024; Kotharkar & Ghosh, 2022
17. WMO, 2023; Kotharkar & Ghosh, 2022
18. ANR, 2015; GGHIN, 2019; Oka et al., 2023; UKHSA, 2023
19. WMO, 2023; Venkata Sarath Chandra and Kai Wei Lee, 2025
20. WMO, 2025
21. Martinez et al., 2022; Kotharkar & Ghosh, 2022, GHHIN et al., 2025
22. O'Connor et al., 2025
23. Dalugoda et al., 2025; Czerniewska et al., 2025
24. Sources for Figure 5: C40 Cities (2016); City of Cape Town (n.d.); Climate Adapt (2016); Climate Adapt (2025); Climate Adapt et al. (2019); Climate Resilience for All (2025); European Environment Agency (2024); Global Heat Health Information Network (n.d.); Global Heat Health Information Network (2025); IFRC et al. (2025); Institute International Du Froid (2025); Local Governments for Sustainability (2025); Seoul Metropolitan Government (2025); South Asian Meteorological Association et al. (2024); State News Agency of Turkmenistan (2021); Swiss National Centre for Climate Services (2025); The World Bank (2025); Trajanov, D. (2018); United Nations Office for Disaster Risk Reduction (2025); World Administrative Boundaries: WFP (2019); World Health Organization (2023); World Weather Attribution (2025).
25. Sources for Figure 6: C40 Cities (2016); City of Cape Town (n.d.); Climate Adapt (2016); Climate Adapt (2025); Climate Adapt et al. (2019); Climate Resilience for All (2025); European Environment Agency (2024); Global Heat Health Information Network (n.d.); Global Heat Health Information Network (2025); IFRC et al. (2025); Institute International Du Froid (2025); Local Governments for Sustainability (2025); Seoul Metropolitan Government (2025); South Asian Meteorological Association et al. (2024); State News Agency of Turkmenistan (2021); Swiss National Centre for Climate Services (2025); The World Bank (2025); Trajanov, D. (2018); United Nations Office for Disaster Risk Reduction (2025); World Administrative Boundaries: WFP (2019); World Health Organization (2023); World Weather Attribution (2025).
26. Cruz et al., 2025
27. Kroeger, 2023
28. Laue et al., 2022; CARE, 2023; Pinoh-Gomes, Mcintosh & Woodward, 2024
29. Johar et al., 2025, Turek Henkins et al., 2021
30. Described in Philip et al., (2020), with supporting details found in van Oldenborgh et al., (2021), Ciavarella et al., (2021), Otto et al., (2024) and here.