FLAGSHIP REPORT

THROUGH THE EYES OF THE MOST VULNERABLE: PERCEPTIONS AND PATHWAYS TO ACTION

IFRC

Climate Centre

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FOREWORD

Extreme heat is a persistent and growing threat around the world. Every nudge up in global warming increases the frequency, intensity and duration of heatwaves. This has devastating consequences, ranging from physical and mental health impacts to disruptions to critical systems – and even heightened conflict. Despite its deadly and wide-reaching impacts, heat remains under-recognized in policy, under-prioritized in adaptation planning and under-resourced in local implementation.

This flagship report, with insights from across the network of the International Federation of Red Cross and Red Crescent Societies, brings together the latest science, risk perception research and voices from affected communities. It presents a bottom-up perspective on extreme heat. Heat disrupts health, weakens social systems and triggers cascading failures in water, food and electrical and transport infrastructure. Red Cross and Red Crescent volunteers see the effects of heat firsthand: from newborns and elderly people showing up more often in healthcare settings, to changes in community life as people use public spaces less and adjust their lives around the hottest times of the day.

People feel the heat, but they don't always recognize its cause, understand its risk, or have the ability to act. Financial, social and systemic barriers prevent people from taking protective action. For example, outdoor workers who are generally young and healthy must make impossible choices between their health and making a daily wage.

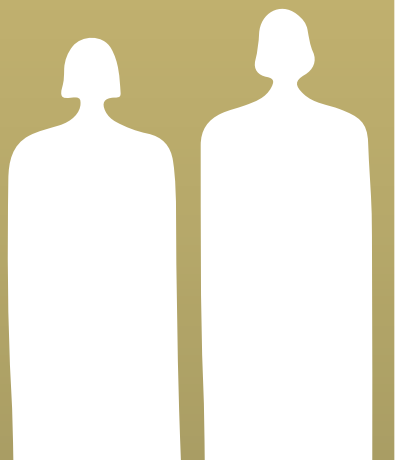
We already have the tools to save lives. In our own network we have raised awareness of heat risks and solutions through Heat Action Day, developed Heat Action Plans in cities and trained volunteers to do first aid for heat and more critical, life-saving actions. Heat Action Plans, early warning systems, urban greening, passive cooling and anticipatory humanitarian action have proven effective. Heat action must be funded, localized and designed with and for those most affected.

This report highlights the experiences of those who are most exposed, least heard and hardest hit. It will serve as a foundation for informed dialogue, strengthened partnerships and decisive steps towards protecting communities from one of the most urgent threats of the climate crisis.

Jagan Chapagain, Secretary General, IFRC

chapter

EXTREME HEAT IS SUPERCHARGED BY CLIMATE CHANGE, YET MANY DON'T REALIZE IT



Visual adapted from Carbon Brief interactive map of extreme event attribution studies 2003-2024.

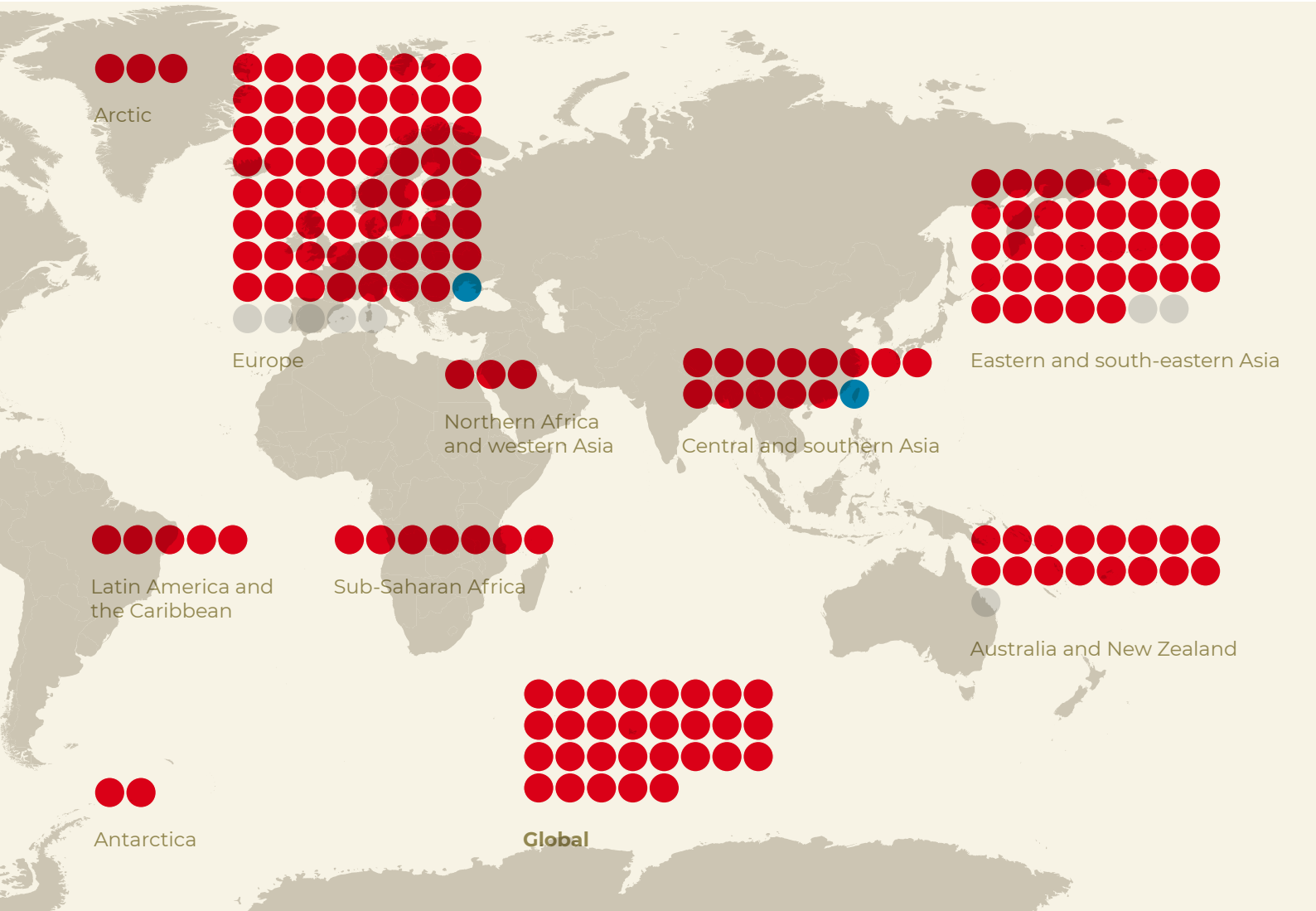
Climate change-fuelled extreme heat is already here. Every increment of global warming is increasing the intensity, frequency and duration of extreme heat.[1] In the 12-month period from June 2024–2025, four billion people experienced at least one additional month's worth of extreme heat[1] days due to human-caused climate change, illustrating the wide-reaching nature of this threat.[2]

Recent headlines highlight the debilitating effects and record-breaking nature of extreme heat. In March 2025, schools were shuttered in South Sudan for two weeks due to a heatwave, disrupting a critical resource for children. This heatwave was made at least 10 times more likely due to climate change.[3] Amongst the 205 heatwave event attribution studies conducted in 2003–2024, 194 found that climate change had made that event more severe or likely, nine were inconclusive, and two found that climate change had no influence on the event.[4]

Even more concerning is the emerging evidence that the changes in heat that people are experiencing are much greater than what climate models can capture.[5],[6] For example, in Central Asia an extraordinary March 2025 heatwave was up to 10°C hotter due to climate change, but the climate models' underestimation of temperatures made it difficult to predict what future extreme heat in the region would look like.[6]

1 Hotter than the 90th percentile of daily maximum temperatures observed in their local area over the 1991–2020 period.

HOW DID CLIMATE CHANGE INFLUENCE EXTREME HEAT EVENTS?



CLIMATE CHANGE-DRIVEN HEATWAVE EVENTS

As part of the World Weather Attribution (WWA) network, the Red Cross Red Crescent Climate Centre (Climate Centre) has developed a system to monitor impactful heatwave events around the world and elevate them for study, broadening the geographic scope of extreme weather events that were studied by scientists. These rapid studies help inform the public about the role of climate change in a particular extreme event, including a number of recent heatwaves.

SAHEL HEATWAVE

In 2024, a heatwave in the Sahel led to maximum temperatures over 45°C across the region, including a record of 48.5°C in Kayes, Mali on 3 April. At the same time, there was a surge in hospital admissions and 102 deaths recorded at Gabriel Touré hospital in Bamako, Mali, with reports indicating that heat likely played a role in many of the deaths.

An attribution study of this event found that the five-day maximum temperatures in the Sahel were particularly unusual with a return time of 1-in-200 years. Observations and models both show that heatwaves with the magnitude observed in March and April 2024 in the region would have been impossible without the 1.2°C global warming to date.

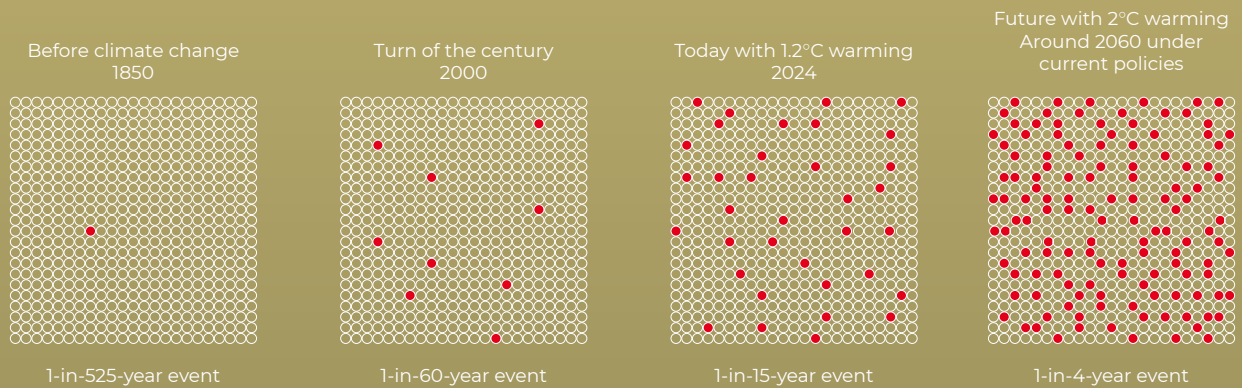
HOW OFTEN SHOULD WE EXPECT SIMILAR FIVE-DAY HEATWAVES IN MALI AND BURKINA FASO?

MAKESHIFT SHADING STRUCTURES IN A MARKET IN NACAOME, HONDURAS (HONDURAS RED CROSS)

NORTH AND CENTRAL AMERICAN HEATWAVE

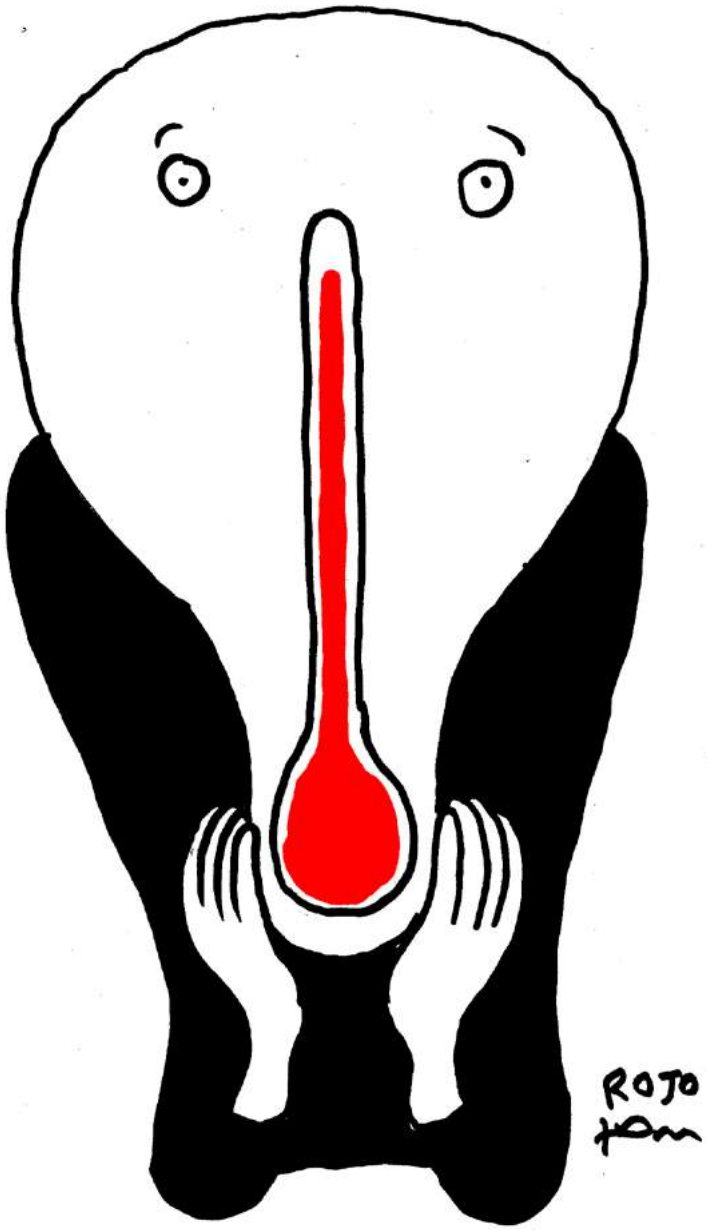
Similarly, an extreme heat event affecting the southern United States, Mexico and Central America in June 2024 resulted in over 100 deaths in Mexico and, combined with air pollution from forest fires, led to emergency measures and school closures. Temperatures in Mexico reached 51.9°C – the hottest ever recorded in June. An attribution study of this event found that climate change increased its likelihood from a 1-in-525-year event before humans started adding greenhouse gases into the atmosphere, to a 1-in-15-year event in today's climate. In a future world with about 2°C of warming, this event would become extremely common, happening about once every four years.

HOW OFTEN SHOULD WE EXPECT SIMILAR FIVE-DAY MAY AND JUNE HEATWAVES IN SOUTH-WEST US MEXICO AND NORTHERN CENTRAL AMERICA?



"You don't need anyone to tell you that we're experiencing heat. Fans blow hot air, the land gets dry, people sleep outside, metal expands." (Ghana)[10]

While the world often places high value and trust in quantitative, objective and expert-centric narratives, we believe that there is also undeniable value in elevating the lived experiences of people. There is growing literature on subjective approaches that consider people's own understanding of their experiences and capacities to measure resilience.[7] Therefore, this report combines scientific evidence and expert narratives with quotations and findings from heat risk perception surveys that have been conducted in locations around the world, especially in developing countries where there has historically been a large gap in heat research. We endeavour to illustrate a bottom-up perspective on extreme heat and highlight instances in which people's perceptions concur with the dominant academic narratives on extreme heat and points of disconnection or contention that require further exploration.



The evidence on rising temperatures and more extreme heat events is born out in the lived experiences of people. For example, risk perception research in Nagpur, India, found that 85.3 per cent of outdoor workers surveyed felt that the weather was hotter than before.[8] In Dhangadhi, Nepal, almost all (98 per cent) of the 985 respondents surveyed by the

Nepal Red Cross Society reported experiencing hotter temperatures in recent years.[9]

While people feel the increase in heat, many don't realize climate change is fuelling it and how much worse it will get. The degree to which people connect rising temperatures to climate change varies from location to location. In Dhangadhi, Nepal, people identified climate change, deforestation and the rapid growth of the city's population as the three major factors.[10] In Surabaya, Indonesia, 58.6 per cent of residents surveyed said they believe climate change is the most critical factor driving increasing temperatures.[11] In the same survey, however, 32.43 per cent of respondents indicated they believe that a person cannot die from heat exposure.[11]

Although knowledge and awareness on climate change are rising, many people still do not link extreme heat to climate change, or to significant adverse health outcomes. In northern Ghana, people indicated that the changes they were observing were linked to factors like bush burning, car emissions, population growth, cutting of trees, emissions from factories, and in some cases to the will or punishment of God and lack of communal spirit[10]. A case study in China showed that, while many acknowledged rising heat, few connected it to climate change or expressed concern about long-term trends.[12]

These perception gaps have important implications. When people attribute extreme heat to causes other than climate change, they may not be aware that heat extremes are projected to worsen in the future. Furthermore, when people do not believe that heat can harm their health, this perception can undermine both personal and collective responses. On an individual level, such beliefs may foster fatalism, reducing the likelihood that people will take protective actions or demand better preparedness. At the policy level, they may contribute to inaction, as political momentum often depends on public pressure and a shared sense of urgency. Addressing these gaps in attribution and awareness is therefore essential for building effective heat resilience.

chapter 2

EXTREME HEAT IS THREATENING HUMAN HEALTH AND WELL-BEING, AND DISRUPTING SOCIAL LIFE

The science is clear: extreme heat poses a growing threat to human health. Global assessments estimate that roughly 490,000 deaths are attributable to heat annually, yet mortality is only the tip of the iceberg.[13] Heat exacerbates conditions such as respiratory diseases, cardiovascular diseases and renal disease (chronic kidney disease).[14],[15] It causes physiological responses such as increased heart rate, dehydration, heat cramps, skin rashes, dizziness, appetite loss, breathing difficulties, fatigue and heat stroke. Extreme heat also affects pregnancy and birth outcomes, increasing the risk of stillbirth and preterm labour.[16]

While the physical health risks of heat are well known, heat is also increasingly recognized as a mental health hazard.[17] A growing body of research links heat exposure to a spectrum of mental health outcomes, from mild psychological distress to severe psychiatric emergencies, as heat has effects such as stress, sleep disturbances, irritability, cognitive impairment and a heightened risk of psychological distress.[18] Heat is associated with increased suicide rates, more frequent hospital admissions for mental disorders and overall declines in community well-being.[19]

These impacts are documented worldwide. In the United States, extreme heat has led to increased emergency visits for mental health conditions including childhood-onset behavioural disorders, substance abuse, stress-related and mood disorders, schizophrenia and self-harm[20]. Similar patterns have been found in China, Italy, Switzerland and Viet Nam, where hospitalizations for mental and behavioural disorders have increased significantly due to extreme heat[18]. In Mexico and the United States, extreme heat influences not just health outcomes but also public sentiment, reflected in increased depressive language on social media[21].

INDONESIA RED CROSS VOLUNTEERS CONDUCTING A FIRST AID DEMONSTRATION FOR HEAT RELATED ILLNESSES. (INDONESIA RED CROSS)

One key pathway through which heat affects mental health is via sleep disturbances, which are strongly influenced by high night time temperatures that don't permit restorative sleep. Globally, sleep loss due to high temperatures rose by five per cent in 1986–2005 and 2019–2023, reaching a record six per cent of total sleep hours lost in 2023 due to heat.[22] Poor sleep not only worsens mood and suicidality but is also linked to physical conditions such as cardiovascular disease, obesity and diabetes.[23],[22],[24] Sleep loss also undermines cognitive function, with laboratory studies showing impairments in attention, memory and executive functioning.[18]

Many respondents in community surveys also emphasized the impact of extreme heat on sleep. With indoor spaces too hot at night, some chose to sleep outdoors, facing risks of mosquito bites, malaria or theft.

"We get psychologically sick whenever the hot season and these heatwaves come, because we know trouble is upon our gardens." (Zimbabwe)[25]

"When heat sets in, even wind doesn't blow again... . I can't even sleep at night when the heat comes." (Ghana)

These effects have cascading consequences in workplaces, schools and emergency services – contexts where optimal decision-making is critical. For instance, emergency responders may face reduced alertness and slower reaction times due to both direct heat exposure and heat-related sleep loss, even as demand for crisis responses surge during heatwaves.

"Drivers' performance can be influenced by their mood to a large extent ... they are more likely to be agitated in hot weather... and you'll not expect a pleasant ride... ."

(Bus team leader)[26]

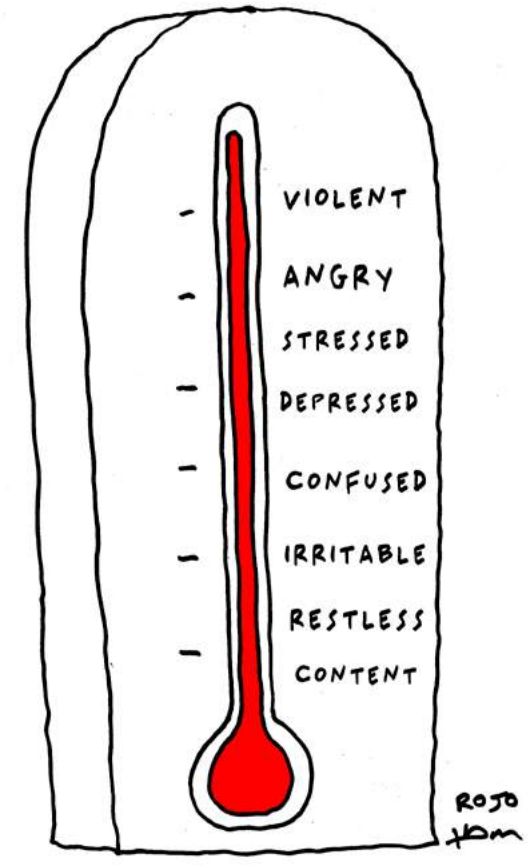
Beyond cognitive strain, prolonged exposure to extreme heat contributes to emotional exhaustion, irritability and heightened interpersonal tension[17]. Research has linked extreme heat not only to anxiety, depressive symptoms and sleep disturbances, but also to an increase in aggressive behaviours, including spikes in domestic violence and community-level conflict[19]. For example, one analysis in Mexico links high temperatures to more homicides and intergroup killings by drug trafficking organizations[25]. The physiological and psychological toll of heat compounds over time, especially when high temperatures persist for days or weeks, creating a volatile social environment alongside deteriorating mental and physical health.

"My neighbours always clash with me in the hot season. They want me to provide water for free and I cannot do that because I paid lots of money to sink this well. So, a lot of gossiping goes around. Some even threaten to throw dead pets in my well, but I can only give them when I have enough to share. I can't be providing for everyone. I am not the government."

(Zimbabwe)[22]

UNDERSTANDING SILENT IMPACTS THROUGH COMMUNITY-BASED SURVEYS

In many countries, especially those with inadequate health surveillance systems, formal data often fails to capture the full scope of heat-related impacts.[27] Even in data-rich settings, extreme heat is rarely recorded as an underlying cause of death or morbidity, masking the true scale of the problem. Community-based surveys and interviews offer critical insight into both health and social consequences that are otherwise missed. They help identify unrecognized symptoms, capture indirect effects and highlight vulnerable groups. In addition, researchers have also turned to alternative data sources such as social media to detect heat-related trends and the population's well-being.[21],[28],[29]



OUAGA2COOL PROJECT COLLECTS MISSING DATA ON HEAT IMPACTS IN OUAGADOUGOU, BURKINA FASO

The Sahel is a region of the world where temperature regularly surpass 40°C, yet we rarely hear about the impacts of heat because of a lack of data and evidence of mortality and morbidity from extreme heat events. This can, in turn, limit awareness-raising and the motivation to take preparedness measures. An innovative project in 2024, when temperatures reached 48.5°C in the region, attempted to fill this gap.

The Burkina Faso Ministry of Health, the Burkinabe Red Cross Society and the Climate Centre collaborated on a mixed method cross-sectoral study that found a range of health impacts and vulnerability factors, including documenting 2,210 deaths in the city. The researchers combined data from a population-based survey, mortality data collected directly from morgues, and interviews with health workers and cemetery staff in Ouagadougou. They were able to document the timing of deaths (37 per cent of all excess deaths occurred in April 2024, with another 32 per cent in the following two months) and vulnerability factors (15 per cent of deaths were children under five years old and an additional nine per cent were adults aged 60–65) as well as documenting co-morbidities and causes of death (stroke 12 per cent, kidney disease 11 per cent and respiratory pathology 11 per cent). Stress on health workers and those working in morgues was also documented. This initial research marks an important effort to document and bring light to heat-related mortality during extreme events in understudied parts of the world.

In Uganda, residents of Kampala's informal settlements reported a range of physical symptoms attributed to extreme heat, such as severe headaches, skin rashes, dehydration, kidney stones, fatigue and cardiovascular and respiratory problems[30]. Similar accounts emerged from rural Zimbabwe, where residents linked unexplained skin conditions to extreme temperatures.

In Nepal, community focus groups said that heatwaves "induce anxiety, depression and aggression",[31] while key informants in Uganda associated rising temperatures with increased stress and substance abuse. [30]

"I can't go out with my friends due to heat ... it costs since we then need a car and refreshments for the outing and conversation to be fun ... [so] I no longer have a pleasing social life due to heat, I barely meet up with my friends ... ." (Zimbabwe)[22]

"At one time, I developed a rash that I could not understand, only to be told at the clinic that it was all caused by heat." (Zimbabwe)[22]

HEAT DISRUPTS DAILY HABITS, SOCIAL LIFE AND COMMUNITY COHESION

Extreme heat alters how people live and interact. Daily routines are adjusted to avoid the hottest hours of the day. Schedules and traditions are rearranged around the thermometer. Midday gatherings like markets, religious services and sports events are cancelled or rescheduled. Playgrounds fall quiet under intense heat, as events are postponed and playground materials get too hot to touch. A key informant in the south of Honduras commented that a newly renovated park for children remained largely unused due to a lack of shade.[32] In many cities around the world, individuals spend far less time outdoors during periods of extreme heat, cutting back on leisure outings, shopping trips and socializing.[33],[34] In the United States, public transport use dropped by nearly 50 per cent on very hot days, as those who could, preferred to travel in air-conditioned private vehicles.[33] In China, a surge in lunchtime food delivery orders was found during heatwaves, as people avoided going outside.[35]

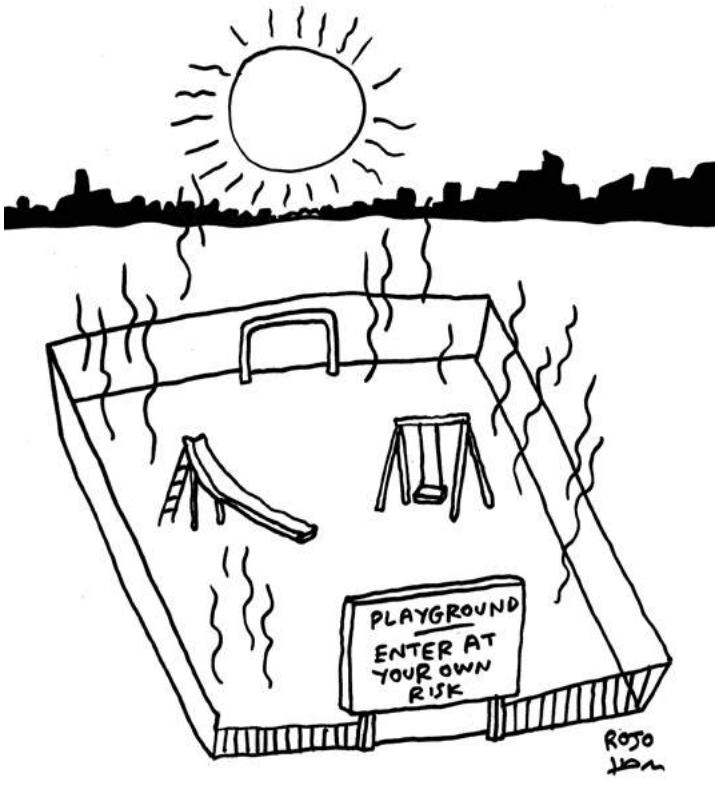
In many countries, including the Philippines and South Sudan, schools were forced to close due to extreme heat, affecting children's education and social development.[36],[37] UNICEF estimates that one-third of the world's children already face four to five heatwaves annually.[38] In overcrowded or poorly ventilated homes, school closures may even increase children's exposure to indoor heat.

"Social gathering tends to reduce because people limit their movements during heat periods and there are no verandas or shade where they can seek refuge ... this reduces social cohesion and wastes time since some functions and activities like sports get postponed." (Uganda)[30]

"We are not able to visit others, or go to churches or clubs. Our husbands do not go for soccer." (Zimbabwe)[22]

EXTREME HEAT ISOLATES, YET CONNECTION SAVES LIVES

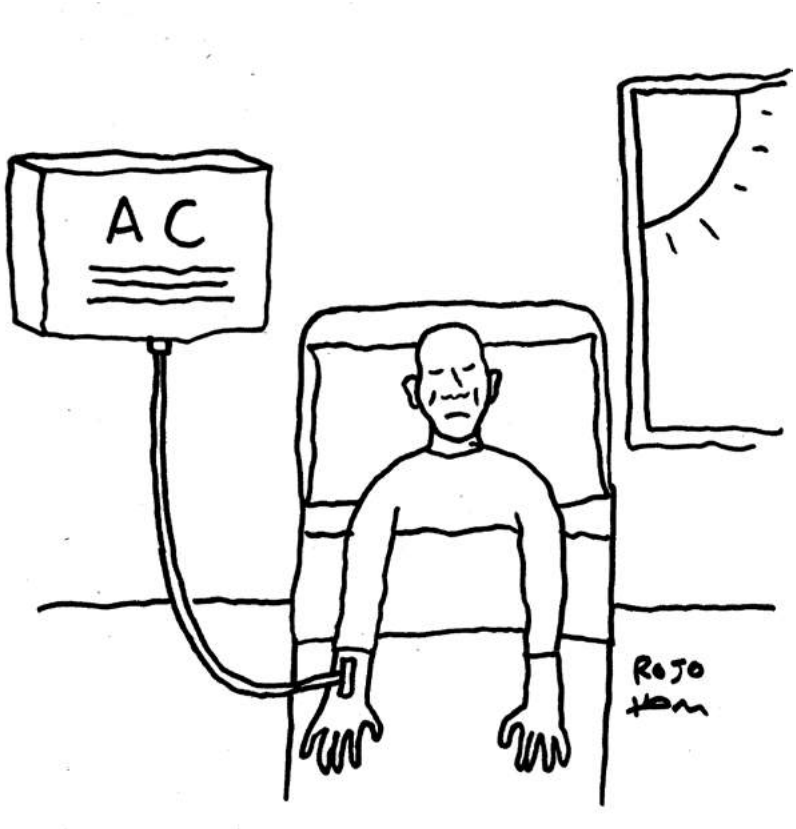
While extreme heat often forces people indoors, social connection is a key protective factor. Those who live alone or lack strong social ties face significantly higher risks during heatwaves.[33],[39] Older adults, in particular, have been found to struggle to adapt routines and are more likely to suffer from isolation.[33] Furthermore, indoor temperatures can sometimes be hotter compared to outdoor shaded areas. During the 1995 Chicago heatwave, strong social cohesion helped reduce heat-related deaths among Hispanic communities compared to non-Hispanic groups.[40] Similarly, today, social infrastructure and solidarity, such as inviting others into cool spaces, organizing neighbourhood check-ins, and opening libraries or community centres, remain vital.



HEAT STRAINS THE SYSTEMS WE DEPEND ON

Extreme heat doesn't only harm individuals, it threatens the interconnected systems that underpin daily life: electricity, food, healthcare and water. Periods of extreme heat can strain systems and trigger cascading failures that multiply risks and increase inequalities.

As temperatures rise, so does electricity demand, as more people turn to fans or air conditioning. In areas without sufficient capacity, this demand can lead to rolling blackouts or total system failure. And when the power cuts off, so does access to cool spaces; water pumps shut down; medications and food spoil; and critical hospital equipment ceases to function. For example, in India, heatwaves have been documented to increase the country's electricity demand for cooling, reducing coal stockpiles and contributing to blackouts.[41]



Water systems are similarly strained. Heat, especially when compounded by drought, accelerates evaporation from rivers, reservoirs and water tanks, even as household and agricultural demand increases. Without functioning infrastructure, access to safe, clean water becomes uncertain, affecting everything from hydration and hygiene to medical care and food production.

Health systems may become overwhelmed during periods of extreme heat, as it significantly increases the incidence of respiratory, cardiovascular and renal illnesses. When combined with other stressors, like humidity or air pollution, this can have compounding effects on cardiovascular, respiratory, maternal and neonatal health, and overall mortality.[42] Heatwaves can worsen air pollution by increasing the production of ozone and particulate matter, which not only trap more heat in the atmosphere but also elevate the risk of respiratory and cardiovascular problems.

These breakdowns hit hardest where systems are already weak. Informal settlements, under-resourced regions and conflict-affected areas often face the most severe disruptions. People living in contexts of fragility, conflict and violence are often at higher risk of exposure to extreme heat, including in refugee camps. Conflict leads to the destruction of housing and electricity and water infrastructure, leaving populations without shelter or the means to cope with extreme temperatures. In South Sudan, for example, extreme heat has severely

BANGLADESH RED CRESCENT VOLUNTEERS DISTRIBUTING WATER AND SHARING HEAT SAFETY TIPS WITH AN OUTDOOR WORKER. (BANGLADESH RED CRESCENT)

impacted internally displaced persons living in makeshift shelters with little protection from the sun.[3]

Food systems, global economies and trade are also increasingly vulnerable. In 2022, extreme heat contributed to a 4.5 per cent decline in India's wheat production, increasing local food prices and prompting the Indian government to ban wheat exports in lieu of increasing wheat exports to support globally low supply due to the Russia–Ukraine conflict.[43] This prompted an estimated six per cent increase in the Chicago benchmark wheat index when global wheat prices were 56 per cent higher in May compared to the previous year.[43]

Despite growing recognition, the broader consequences of extreme heat remain underestimated. It is quietly but profoundly reshaping how, when and whether people gather, work, rest and feel safe in their own homes. As short-lived heat events give way to weeks-long episodes, these disruptions are no longer rare; they are becoming the new normal. Extreme heat is not just a health hazard, it is a systemic stressor that multiplies risks across the essential systems we depend on, from water and energy to healthcare, food and labour. A more holistic vulnerability assessment ecosystem, spanning ecological, economic and social dimensions, is needed to inform anticipatory financing, equitable urban planning and heat-responsive policy design. Its impacts cascade through societies, compounding vulnerabilities and increasing inequalities. These are not merely technical failures, they are social and political challenges that determine who is protected, who can adapt, and who is left behind.

"I always get asthmatic attacks when it is very hot. Breathing becomes very difficult for me, and I constantly need help. It is a very difficult time for me."

(Zimbabwe)[22]

Chapter 3

TO CHANGE BEHAVIOUR, HEAT RISK MESSAGING MUST BE INCLUSIVE, TARGETED AND ADDRESS SOCIO-PSYCHOLOGICAL DRIVERS

Heatwaves are becoming more frequent and severe, yet they often receive less public attention than more 'dramatic' hazards like storms or floods. Many people underestimate the risks of extreme heat, not realizing how quickly it can harm their health. Risk perception is often misaligned with actual vulnerability: for instance, elderly individuals may not consider themselves "old enough" to be at risk,[44] and, in hot climates, people may become desensitized and normalize dangerous temperatures. These perception gaps highlight the critical role of risk communication in bridging knowledge and action to reduce heat-related impacts.

However, simply raising awareness is not enough if it does not lead to protective behaviour. A significant gap exists between knowledge and action, often referred to as the 'warning–behaviour gap'.[45] Closing this gap requires communication strategies grounded in behavioural science that acknowledge the psychological and social drivers of behaviour, such as perceived risk, emotional responses, trust, social norms and access to resources.[45] Effective messaging must speak directly to lived experiences and be inclusive of those most at risk, recognizing the diversity of needs and barriers to action.

HEAT RISK PERCEPTION IS INCREASING

Self-reported data confirms that risk perception is shaped by personal experience, emotion and social context. In Nagpur, India, outdoor vendors with pre-existing illnesses were significantly more likely to feel vulnerable, worry about their families and report fear of heat-related illnesses.[46] In another study, underprivileged workers were unaware of the link between heavy labour in hot, humid conditions and serious health issues like kidney disease, underscoring the need for better-targeted awareness.[46]

While many communities around the world are aware that extreme heat can lead to negative health impacts, not everyone perceives themselves as vulnerable to extreme heat. Although some vulnerable subgroups have shown to report higher risk perceptions compared to less vulnerable groups, this does not always translate to perceived personal risk; for example, older adults frequently underestimate their own vulnerability towards heat.[44] Similarly, in Nepal, most survey respondents agreed that heatwaves are a serious issue (60 per cent), while also agreeing that their body is "used to (resistant to)" heatwaves (65.7 per cent).[31] While this likely speaks to acclimatization to a particular level of heat, this type of perception also risks underestimating higher heat-risk because of climate change.

It is crucial to raise awareness about the dangers of extreme heat and the steps that can be taken to mitigate these risks. Campaigns aimed at raising awareness of extreme heat can educate city residents, local government officials, students, healthcare providers, humanitarian aid workers and political leaders about the impacts of extreme heat. These campaigns also inform them of simple actions they can take to reduce exposure and safeguard people's well-being.

The types of communication channels used will affect how heat information is shared. Information can be conveyed through visual, audio or text formats. Using a combination of these formats can reach a broader audience than relying on just one type.

ARTIST IN ZANZIBAR, TANZANIA CREATING A PAINTING TO RAISE AWARENESS OF HEAT RISKS FOR HEAT ACTION DAY 2024. (TANZANIA RED CROSS)

HEAT AWARENESS RAISING CAMPAIGNS IN NEPAL, INDONESIA, BANGLADESH, AND TANZANIA

The Climate Centre has been working with Red Cross and Red Crescent National Societies and partners in Nepal, Indonesia, Bangladesh, Honduras and Tanzania to communicate the risks associated with extreme heat and ways to alleviate its adverse impacts on health and well-being. Since 2022, the Nepal Red Cross Society (NRCS) has designed and conducted extensive heat awareness campaigns in cities such as Nepalgunj, Siddharthnagar, and Biratnagar. These campaigns occurred from April to June during the peak heat period. The NRCS employed a variety of communication channels and formats to convey heat awareness messages, including print and outdoor publishing through posters and billboards, social media platforms such as Facebook and WhatsApp, as well as TV and radio broadcasts. In-person communication was also utilized, including distributing leaflets specifically to vulnerable groups such as older adults (over 65 years), individuals with chronic medical conditions, pregnant and lactating women, and outdoor workers in heat hotspots. The NRCS also visited schools to educate students about the risks of extreme heat and how to manage them.

In Indonesia, the **Indonesian Red Cross (PMI)** supported university students in implementing community-level actions and developing communication materials to raise awareness in cities like Medan.

The Bangladesh Red Crescent Society (BDRCS) distributed hand fans with awareness messages in Dhaka to increase awareness among community members. The BDRCS also organized painting competitions for school students focused on extreme heat risks and management.

The **Tanzania Red Cross Society (TRCS)** adopted innovative measures to spread awareness about extreme heat risks. Volunteers painted informative messages on banners, while in Unguja city, TRCS utilized divers as volunteers who held a printed banner and jumped into the sea at a public beach in Zanzibar. This entertaining approach aimed to promote heat action messages to children, tourists, and market vendors. Social media posts were also shared to disseminate these crucial messages further.

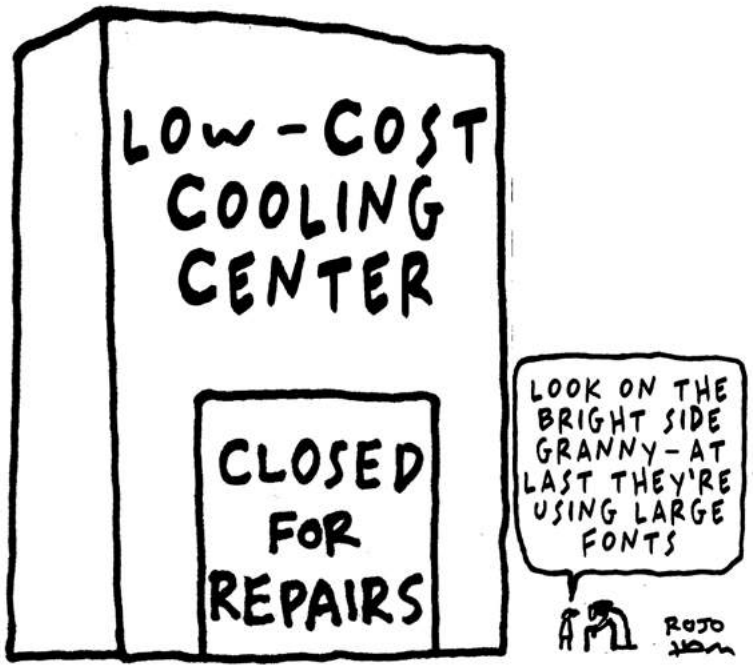
Free and editable heat awareness raising materials are available in our Heat Toolkit.

BANGLADESH RED CRESCENT VOLUNTEERS DOING A FLASHMOB TO RAISE AWARENESS OF HEAT RISKS AND SOLUTIONS ON HEAT ACTION DAY 2024. (BANGLADESH RED CRESCENT)

MAKE MESSAGING ACCESSIBLE (LANGUAGE, FORMAT, CHANNELS) AND EVALUATE

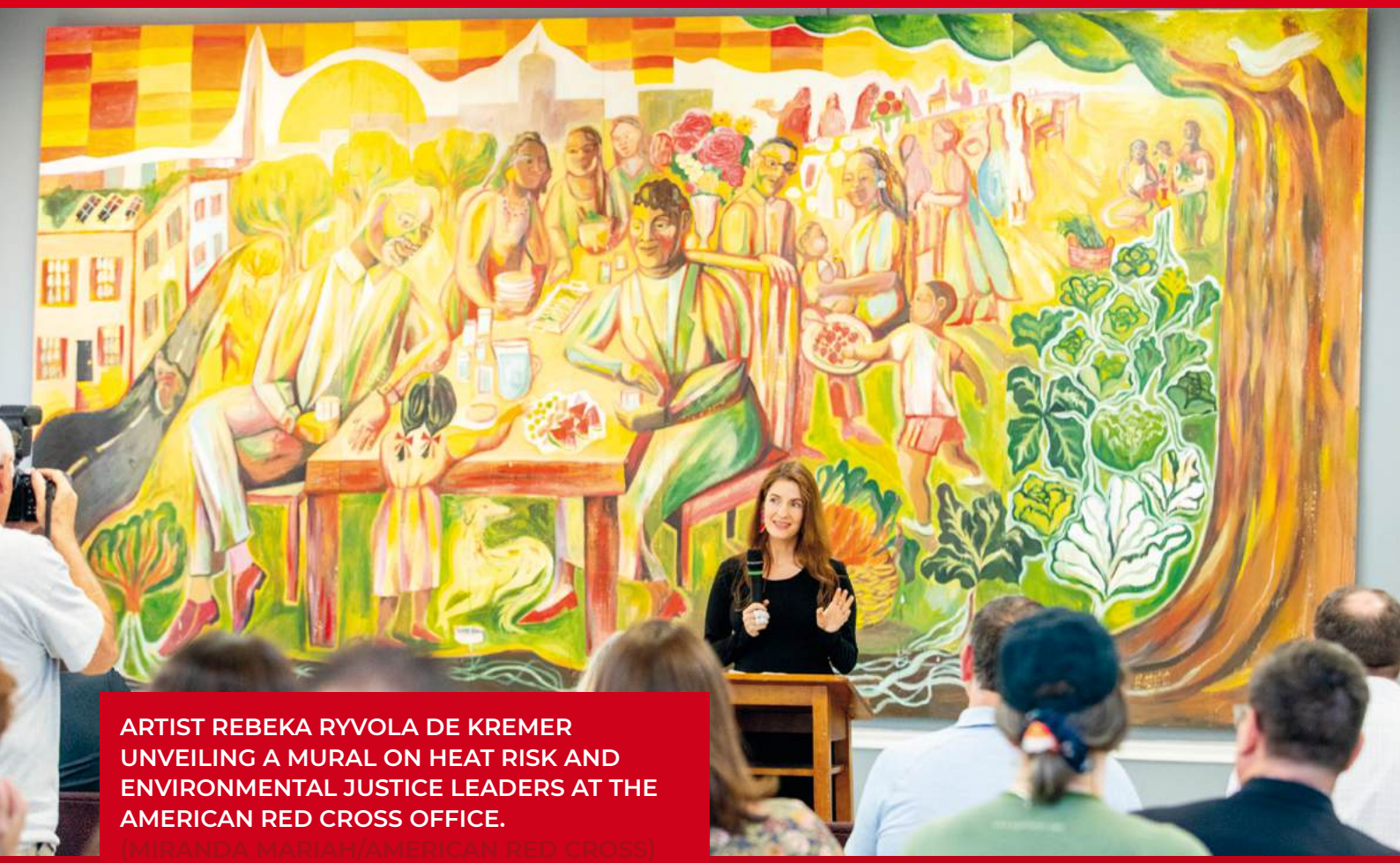
One-size-fits-all campaigns are frequently ineffective, particularly when they fail to reach the most vulnerable populations, such as older adults, migrants, non-native speakers and people experiencing homelessness. Tailoring messages to specific groups, using accessible formats (e.g. large print, pictograms) and translating them into multiple languages are key strategies.[47] Multilingual phone alerts, large-print flyers in retirement homes, and in-person outreach by social workers are examples of inclusive communication. Campaigns must also consider trust: communications are more effective when delivered by trusted messengers, such as local leaders or community organizations, and when they use clear, actionable guidance that explains both the risks and the steps needed to reduce them.[48],[49] Where possible, campaigns should also be evaluated to assess reach, effectiveness and areas for improvement.

VISUAL COMMUNICATION



Although heat risk communication is often thought of in terms of text or oral messages, visual communication plays a crucial role. Images used in media reports or public campaigns can shape perceptions. Recent analysis points out that media coverage of heatwaves frequently shows "fun in the sun" visuals (e.g. people at the beach, kids in fountains) which may trivialize the risk.[50],[51],[49] Such images do not convey that extreme heat is hazardous. On the other hand, it's also helpful to include visuals of protective actions and community responses (e.g. an air-conditioned cooling centre, volunteers distributing water) to give audiences a sense of what can be done.

CREATIVE, ART-BASED APPROACHES TO INCREASE HEAT-RISK AWARENESS



ARTIST REBEKA RYVOLA DE KREMER UNVEILING A MURAL ON HEAT RISK AND ENVIRONMENTAL JUSTICE LEADERS AT THE AMERICAN RED CROSS OFFICE. (MIRANDA MARIAH/AMERICAN RED CROSS)

Different forms of art can help connect the issue of heat with more people. For example, thermodynamic paint that changes colour based on the temperature to reveal an underlying message can be an unexpected way to teach people about the risks associated with heat. Heat Action Day in 2024 focused on creative, art-based strategies to raise awareness about the dangers of extreme heat. Communities worldwide participated by creating murals, paintings and other artworks to highlight the impact of extreme heat, particularly on vulnerable populations.

Recognizing that heat is often a silent and invisible killer, the Climate Centre commissioned artists Andrew Rae and Ruskin Kyle to create compelling visuals that re-imagine heat to show its incredibly deadly track-record and wide-reaching impacts. The artists depicted heatwaves as monstrous robotic invaders threatening urban environments and people. This imaginative portrayal is a playful but serious approach to helping the public understand the reality of heat risks.

In the United States, artist Rebeka Ryvola de Kremer created a mural unveiled by the American Red Cross on Juneteenth 2024 in Silver Spring, Maryland. The artwork features symbols of heat stress reduction, such as tree planting and green spaces, and portrays environmental justice leaders like Hazel Johnson and Robert Bullard. The artist emphasized the importance of empowering communities to address climate challenges.

These initiatives demonstrate the power of art in communicating complex climate issues and engaging diverse audiences in meaningful dialogue.

BEHAVIOURAL SCIENCE MUST BE LEVERAGED WHEN CRAFTING MESSAGES

Effective heat communication should leverage principles from psychology about risk perception and behaviour change.[45,52] Theories emphasize that people are more likely to act when they perceive personal vulnerability, believe the recommended action is effective, and face low barriers to acting.[48] Messages should therefore underscore risk ("even healthy adults can suffer heat stroke"), explain efficacy ("cooling down reduces 90 per cent of illnesses") and reduce perceived costs ("cooling centres are free and open to all"). Simple advice like "drink more water" may not change behaviour. Some may avoid drinking water because it increases the need to urinate, they dislike the taste, or they're unsure how much is enough. Effective messaging must account for these real-world barriers and embed behavioural insights to increase uptake.

A communication pitfall, however, is overemphasizing individual responsibility without acknowledging structural barriers. Advising low-income households to "seek cool spaces" overlooks financial, logistical and social realities. Without support, such as free transportation to cooling centres, such advice can seem out of touch, potentially undermining trust and future compliance.[47] Campaigns that promote shared responsibility (among individuals, communities and authorities) and clearly state available services are far more effective.

CONNECT HEAT MESSAGING TO BROADER CONTEXTS

Heat messaging is also stronger when embedded in broader climate and community resilience narratives. In some settings, linking extreme heat to climate change can help motivate policy and collective action; in others, emphasizing immediate, local health risks may resonate more. Messages that reflect social norms, such as caring for family or looking out for neighbours, can encourage protective behaviours, even where climate change narratives may not resonate. Trust can also be built through tiered messaging: emphasizing that while mild heat may affect vulnerable groups, extreme heat threatens everyone. This helps the public take warnings seriously at the right time. Two-way communication is also essential; local engagement through co-designed messaging helps ensure that outreach is contextually relevant and avoids misinformation.[49]

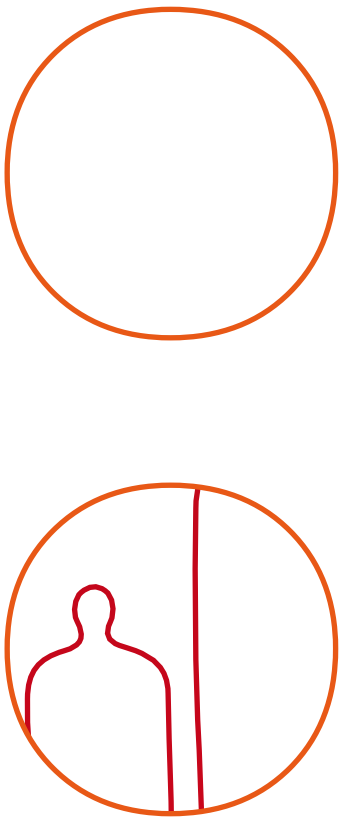
There is also growing recognition of the need for multi-hazard risk communication. Extreme heat can overlap with other risks such as wildfires, poor air quality or infectious disease outbreaks like COVID-19. Clear, coordinated messaging that addresses these interacting risks can prevent confusion and better guide protective action. For example, the Global Heat Health Information Network (GHHIN) – an independent, voluntary and member-driven forum of scientists, practitioners and policy-makers focused on improving capacity to protect populations from the avoidable health risks of extreme heat in our changing climate – developed guidance on managing heat risk during the COVID-19 pandemic. This illustrates how integrated communication can protect public health while navigating complex trade-offs.[53]

Overall, successful heat-risk communication is people-centred, context-aware, action-oriented, targeted and rooted in behavioural science. It requires speaking to people in their language, leveraging psychology to drive behaviour change and ensuring that messages come with the support needed to act on them. When done well, heat-risk communication can save lives by bridging the gap between awareness and action. But even the best messaging falls short when people face real-world barriers that limit their ability to act.

ART BY ANDREW RAE AND RUSKIN KYLE TO ILLUSTRATE THE "INVISIBLE THREAT" OF EXTREME HEAT. (ANDREW RAE AND RUSKIN KYLE)

EVEN WHEN PEOPLE RECOGNIZE THE RISKS OF HEAT, THERE ARE PRACTICAL, SOCIAL AND FINANCIAL BARRIERS THAT PREVENT ACTION

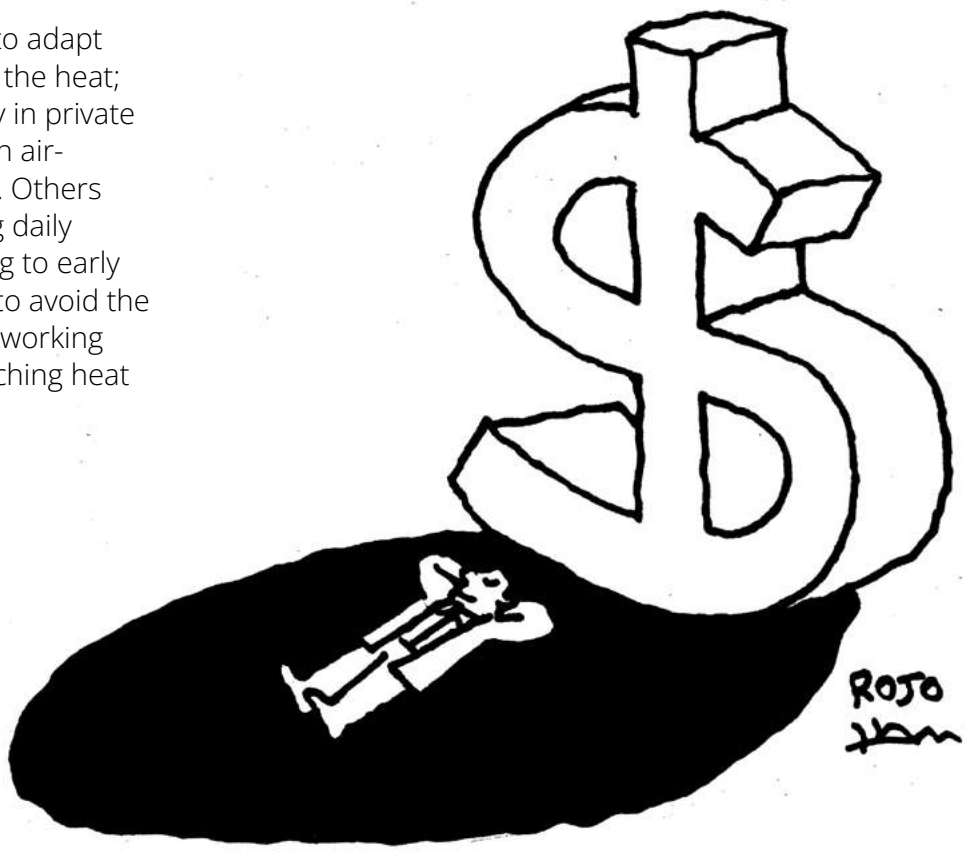
chapter



Awareness alone does not guarantee adaptive behaviour. Affordability rather than optimal efficacy often dictates adaptation strategies for individuals facing economic hardship.[45],[44] Structural conditions, such as unreliable electricity, limited access to water and insufficient urban planning, constrain the feasibility of basic protective measures. Socio-cultural dynamics, including social norms, workplace expectations and daily survival imperatives, frequently act as barriers to adaptation, even in cases where individuals are informed and motivated to respond. Factors like gender, income and education as well as the social network around individuals play a role in heat adaptation behaviours.[54],[55]

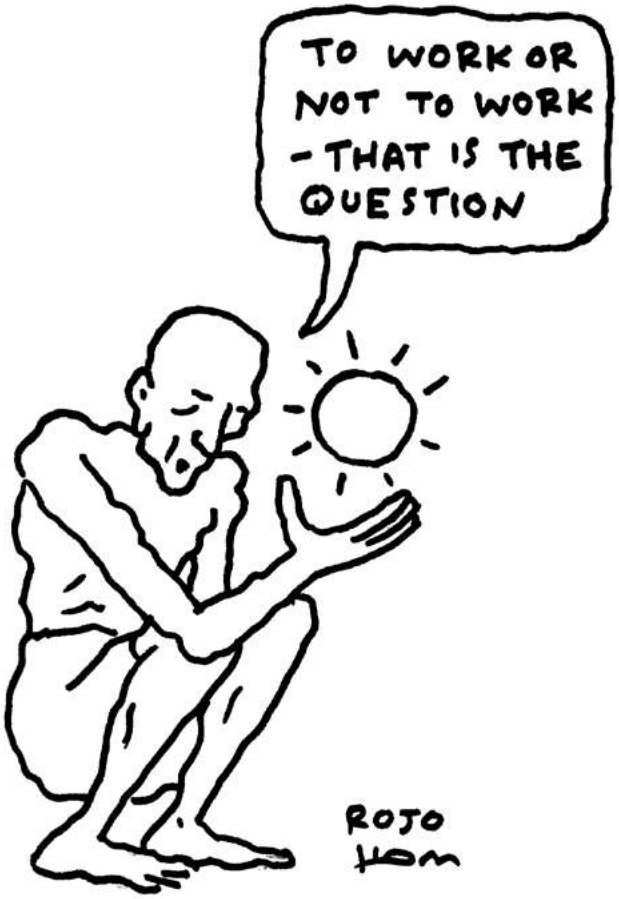
Some people do not have to adapt their daily life much due to the heat; they can go about their day in private cooled vehicles or shelter in air-conditioned indoor spaces. Others must plan carefully, shifting daily habits like grocery shopping to early mornings or late evenings to avoid the heat. Some must continue working outdoors, exposed to scorching heat without relief.[56]

People's testimonies underscore the lived experiences behind these research findings. In Zimbabwe, street vendors describe a constant trade-off between economic survival and exposure to dangerous temperatures. One vendor noted, "*You need to brave the heat in order to gain more customers.*" Another remarked, "*Our fellow vendors who are lazy and weak abandon their work when there are heatwaves. Some of us then grab that opportunity.*" These comments illustrate how economic incentives and prevailing social narratives may discourage rest or precaution during extreme heat events.



"Swimming pools are there but they are for rich people. You can't waste money on swimming when you struggle to put food on the table."

(Zimbabwe)[22]



In Nepal, a worker said, "*There is no option for us other than getting exposed to sun at work. This work is the only option for running our daily life. If we do not work in the day, we won't have food in the evening*." The absence of viable alternatives forces individuals to continue working through the most hazardous hours, regardless of the known risks.

A survey among the auto/toto and rickshaw drivers (three-wheeled vehicles) in Rajshahi, Bangladesh indicates that "*they lose 20 per cent and 18 per cent of their income, respectively, if they reduce four hours of work over three high heatwave days*".[57] In Dhangadhi, Nepal, 54 per cent of survey respondents reported spending more money during the hot seasons to cope with extreme heat. The additional expenditure goes towards healthcare, electricity and purchasing water or other soft beverages. In Surabaya, Indonesia, a risk perception survey found that 33 per cent of respondents believe that tiredness or sickness caused by heat was unavoidable.[11]

Access to public cooling facilities remains uneven and frequently exclusionary.

Extreme heat often drives people indoors. In neighbourhoods where investments in social infrastructure – like libraries, cooling centres and local groups – are missing, the isolating effect of heat is made worse. Poorly constructed buildings, combined with limited or a lack of access to cooling technologies or the inability to afford their use, can result in dangerously high indoor temperatures. Despite these risks, there is little evidence on safe indoor heat levels or effective, affordable solutions to reduce indoor overheating. Detention facilities and refugee camps are often overlooked places where indoor heat risks are even more severe.[58],[59] Detention facilities can be overcrowded, poorly ventilated and badly maintained.[60] Extreme heat intersects with already harsh conditions, leaving many detainees facing life-threatening risks.

"The ambient heat combined with the unbearable smell of urine, faeces and other waste clearly demonstrate the difficult conditions in which those in custody are held." (Niger)[61]

Widespread informality, such as in South Asia where nearly 75 per cent of non-agricultural workers lack formal employment, means many workers are excluded from labour protections and social safety nets.[62] As temperatures rise, the absence of formal workplace safeguards, such as rest breaks, adjusted work hours, water access or alternative duties, leaves informal workers exposed to serious health risks, including heat-related illnesses and injuries.[63]

Those who are most directly exposed to extreme heat (e.g. outdoor workers, street vendors) largely have a high risk perception of extreme heat, which is shaped both by local knowledge and prior experiences with heat.[8] Despite this, vulnerable populations often cannot act on heat guidance, such as staying indoors or using cooling devices, because of limited resources, unsafe housing or the need to continue working in high temperatures to survive. Closing the gap between knowledge and action, therefore, demands more than information alone; interventions must pair tested behavioural approaches with comprehensive, equity-oriented adaptation strategies that address the material and social realities of those most at risk.

THE BAHRAIN RED CRESCENT SOCIETY DURING A FIELD AWARENESS VISIT TARGETING OUTDOOR WORKERS TO RAISE AWARENESS ABOUT THE RISKS OF HEAT STRESS AND SUNSTROKE. (BAHRAIN RED CRESCENT SOCIETY)

SCALING INVESTMENTS

Delivering sustainable solutions for building resilience to heat risk requires finance at scale. Estimating how much finance is being devoted to heat resilience is difficult due to data and methodological limitations.[64] That said, there is consensus that action on heat is severely underfunded. This can be implied by the fact that the current adaptation finance gap is now estimated at 194–366 billion US dollars (USD) per year (throughout this decade) and that in 2024 finance for the entire spectrum of adaptation interventions (i.e. not just those focused on heat) amounted to 76 billion USD (this is a mere five per cent of total climate finance).[65],[66] However, some financing is being devoted to tackling heat risk and this comes from a range of sources.

First, this includes finance from multilateral and bilateral funds. Salient multilateral climate funds such as the Green Climate Fund (GCF) and the Global Environmental Facility (GEF) do not provide precise estimates of their investments in heat resilience but support a number of relevant initiatives. For example, this includes the GCF's support for the salient 880 million USD 'Cooling Facility' initiative that "focuses on regulation and policy, technical assistance and financing to address and help remove barriers to the development of sustainable cooling investments" in nine countries.[67] Another example is the GEF's support for the 150 million USD Urban Shift initiative that aims to make 23 cities across nine countries more resilient to a range of hazards, including heatwaves.[68] Bilateral donors such as the Japanese International Cooperation Agency (arguably the world's largest bilateral agency) has an increasing focus on this hazard as exemplified through the 'Action agenda on financing for climate resilience with a focus on extreme heat' (that lists ten action areas for tackling heat) which it launched in early 2025.[69]

Second, national and subnational governments are also starting to invest their own domestic resources. This takes two forms: either governments are funding bespoke initiatives, or actions to build heat resilience are being mainstreamed into public schemes and programmes. An example of the former is the government of California's allocation of 100 million USD in its latest budget for three extreme heat mitigation initiatives.[70] An example of the latter comes from India, where at least 18 major existing government programmes include activities that can tackle heat risk.[71]

Finally, apart from these conventional sources of finance, there are examples of innovative finance mechanisms. This includes resilience bonds (akin to green bonds but focused on adaptation) such

as those issued by California earlier this year and by Cape Town in 2021. Both raise financing from the capital markets and public sources to deliver a range of actions, including those that help enhance resilience to extreme heat. Additionally, there are examples of private investments that contribute to heat resilience. This includes initiatives such as EcoZen that provides affordable, solar-powered cold storage facilities for farmers and Sahaja Seeds that offers heat- and drought-resistant seeds to farmers; both initiatives operate in India.[72]

Overall, there remains immense potential to increase resource flows for tackling heat using these different sources of finance as inadequate housing, unreliable electricity supply and limited access to clean water pose significant challenges, particularly in informal settlements and under-resourced areas. In these contexts, individuals may possess the knowledge and willingness to adapt but lack the means to act on it. Climate adaptation initiatives often operate under the assumption that providing information or material resources is sufficient. However, this overlooks deeper financial constraints that systematically hinder the ability of many communities to implement effective adaptation strategies.[73]

INDIA RED CROSS VOLUNTEERS DISTRIBUTING WATER AT A TRAIN STATION. (INDIA RED CROSS)

Chapter 3

SCALING UP HEAT ACTION WITH EARLY WARNING SYSTEMS AND CROSS-SECTOR HEAT ACTION PLANS IS ESSENTIAL – TAKING EARLY ACTION SAVES LIVES

With climate change driving more frequent and intense heatwaves, scaling up heat preparedness and adaptation is urgently needed worldwide. There are many solutions to extreme heat and this chapter highlights three critical ones that have the potential to reach the billions of people at risk.

HEAT HEALTH ACTION PLANS

Heat Action Plans (HAPs) or Heat–Health Action Plans (HHAPs), are increasingly being developed worldwide as an effective strategy to help cities prepare for extreme heat.[74] These plans offer a framework for addressing heat risks across immediate, short, medium and long-term timeframes. However, significant gaps remain, particularly in cities and regions across Africa and parts of Asia as well as in Latin America and the Caribbean, where few such plans have been developed or implemented.

In short, an HHAP needs to bring together multiple institutions under the leadership of a designated coordinating body to ensure a unified response to extreme heat. These plans aim to reduce exposure to heat, particularly among vulnerable populations, by promoting targeted protective actions, ensuring the provision of essential healthcare and social services and adapting infrastructure accordingly. Real-time health surveillance is integrated to support rapid response, while ongoing monitoring and evaluation help refine interventions and measure impact over time.[75] HHAPs can integrate accurate and timely alert systems, coupled with pre-developed heat–health information, to guide public messaging and action. While intended to work across timescales, a key gap in implementation so far has been the lack of systematic inclusion and targeting of long-term adaptation measures in HHAPs.[76]

A strong example comes from the Nepal Red Cross Society (NRCS) and Movement partners working with municipalities in four cities: Biratnagar, Dhangadhi, Nepalgunj and Siddharthanagar. The Nepalgunj HAP demonstrates how collaboration between local government and humanitarian actors can lead to tangible, sustainable solutions to reduce heat risks. The Plan originated from a 2021–2022 research initiative on the identification of heat thresholds and heat hotspots in Nepalgunj[77] and led Nepalgunj's city authority to allocate resources for key interventions, including installing water ATMs at critical hotspots and establishing a permanent cooling centre with capacity for around 100 people.

COLLABORATION FOR ACTION TO ADDRESS EXTREME HEAT RISK: THE NEPALGUNJ HEAT ACTION JOURNEY

This is a case of a simple research initiative evolving into a successful Heat Action Plan and framework for expansion through collaborative partnerships between National Societies, local government actors and other stakeholders in Nepal.

Nepalgunj Sub-Metropolitan City (SMC), situated in the Terai plains, is an important business hub in Nepal. However, it is grappling with challenges due to rapid urbanization and the escalating impacts of climate change. The Terai region, particularly cities such as Nepalgunj, is experiencing an increase in heat-related health issues, fatalities and economic losses.

Nepalgunj was the first city in the region to take steps to address the risks associated with extreme heat, beginning with a research study in 2021. In that year, the Climate and Development Knowledge Network (CDKN) Asia initiated a collaboration with the Climate Centre to conduct a heat-risk study. The aim was to understand heat risks and vulnerabilities. The Climate Centre collaborated with the NRCS, its Banke District Chapter and the Nepalgunj SMC to conduct the study in Nepalgunj.

This initial research presented an opportunity for additional partners, such as the UK Met Office, to contribute to the effort, turning a rapid assessment of heat hotspots into a thorough analysis of heat risk. In March 2022, all partners jointly released the 'Identification of heat threshold and heat hotspots' report along with a policy brief called 'Reducing heat impacts in Nepalgunj City, Nepal'. These collaborative publications started a conversation, providing valuable insights into the extreme heat risks faced by Nepalgunj.

The local government was encouraged to take steps to address urban heat risks and create a more resilient community. Building on the findings from previous studies and with support from the Norwegian Red Cross along with the Finnish Red Cross, the Nepalgunj city authority and the NRCS developed and published a comprehensive Nepalgunj Heat Action Plan in 2023.

In 2024, the Nepalgunj city authority responded to positive feedback from stakeholders and the community by allocating resources to implement several prioritized measures outlined in the HAP, including the establishment of water ATMs. Furthermore, the city authority has partnered with the NRCS, American Red Cross and the Climate Centre to enhance heat action efforts in the region.

Today, the partnership is taking further steps to raise awareness and reduce risks among vulnerable communities through home visits, distributing free saline or potable water and installing drinking water facilities in schools. Additionally, it is working to establish a cooling centre in a strategic location within the city, which will accommodate up to 200 people as specified in the HAP. This cooling centre is expected to be ready for use by vulnerable population groups in summer 2025. The city authority has covered the majority of the costs, while the American Red Cross is funding the remaining expenses representing a joint financing model.

While HHAPs are a widely used organizing principle for heat action, their implementation can result in particular gaps that are discussed in more detail in Chapter 6.

HEAT EARLY WARNING SYSTEMS, WHEN LINKED TO EARLY ACTION PLANS, CAN SAVE LIVES AND LIVELIHOODS

Extreme temperatures are highly predictable around the world,[78] offering a crucial opportunity for early action.[74] When heat early warning systems (HEWS) are effectively linked to structured early action plans, they can significantly reduce heat-related illness, mortality and disruption to livelihoods. Studies show that many life-saving actions, such as hydration campaigns, targeted public messaging and the activation of cooling centres, are simple, low-cost and highly effective when implemented ahead of time. A recent World Meteorological Organization (WMO) and World Health Organization (WHO) estimate states that expanding heat–health warning systems in just 57 countries could save approximately 100,000 lives annually.[79]

Despite the proven benefits, large coverage gaps remain. Currently only 54 per cent of meteorological services issue warnings for extreme temperatures, and even fewer warn of heatwaves or thermal stress.[80] These gaps are especially acute in Africa, South and Central America, and South East Asia, where communities face growing exposure to dangerous heat. To address these challenges, the WMO and WHO published guidance in 2015 on the development of warning systems for extreme heat, which is currently being updated.[81]

However, even in countries with longstanding systems and action plans in place, extreme heat continues to claim hundreds of lives each year. For example, in 2022, 60,000 people died due to extreme heat across 35 European countries, although countries across Europe are supposed to have some of the strongest warning systems and heat action plans in place.[82]

To improve consistency and comparability across systems, WMO and WHO are now advancing a more standardized and harmonized approach to heatwave warning systems, shifting away from simple temperature thresholds towards more nuanced definitions. Their updated definition conceptualizes heatwaves as "local cumulative excess heat during a sequence of unusually hot days and nights"– better aligned with the cumulative nature of heatwaves, which combine health impacts and infrastructural stress.[79]

Early warning systems are a vital first line of defence, but they are only effective if they trigger meaningful, timely and inclusive early action. Scaling up HEWS coverage, improving the quality and consistency of warning criteria and ensuring systems are designed with the end user in mind, especially in low-resource settings, will be essential to reducing the rising toll of extreme heat worldwide.

TURNING WARNINGS INTO ACTION

Warnings alone do not guarantee action. Research shows that the largest failures in early warning systems are often not technical, but institutional and behavioural. The warning value chain, from detection to decision-making, often breaks down because critical partnerships and communication mechanisms are missing. To fully realize the life-saving potential of HEWS, warnings must be embedded in comprehensive HAPs and supported by operational readiness. This includes regularly reviewing and updating HAPs, training emergency personnel, coordinating with stakeholders, preparing cooling centres for rapid activation and maintaining clear communication and updated contact lists.[83]

Anticipatory Action is an innovative approach in the humanitarian sector that uses forecast triggers for humanitarian action and the financing of these actions, underpinned by so-called Early Action Protocols.[84] Through this approach, preparedness actions can be taken before a disaster strikes.
A first anticipatory action mechanism for heat specifically was formalized in 2019 with the Vietnam Red Cross Society's Early Action Protocol (EAP), although early pilots for heat started 2015–2017. The Red Cross and Red Crescent network has now developed EAPs for extreme heat in Bangladesh, Burkina Faso, Greece, Kazakhstan, Myanmar, Nepal and Tajikistan. For example, in Ouagadougou, Burkina Faso, when the temperature is predicted by the National Meteorological Service to be above 42.4°C for three or more consecutive days, the Burkinabe Red Cross Society will take early actions including awareness-raising among at-risk communities; distributing drinking water, WASH (water, sanitation and hygiene) and dignity kits, food and solar kits (to power fans); and conducting home visits for follow-up and the medical care of people with special needs.

CASE STUDY:

This project was implemented by the IFRC, American Red Cross, Climate Centre and the National Societies of Bangladesh, Honduras, Indonesia and Tanzania. The project focused on secondary cities in the four countries and it aimed to build the climate resilience of urban communities, particularly to extreme heat and coastal threats.

To ensure the project's long-term viability, partnerships were established with critical allies, forming coalitions in each city. A key milestone across the countries was the development of heat perception studies aimed at identifying individual strengths and barriers to heat action and to determine communication strategies to change behaviour and minimize heat impacts in these cities. This served as the evidence base to develop heat awareness campaigns with targeted strategies for identified vulnerable groups.

The work undertaken by each coalition varied by country as did the level of awareness of heat as a risk among the local authorities encountered.

COASTAL CITY RESILIENCE AND EXTREME HEAT ACTION PROJECT (COCHAP)

The climate change coalition of Nacaome, in collaboration with the municipal government and the Honduran Red Cross Society, implemented social micro-projects to reactivate the municipal tree nursery as an action against extreme heat, with the goal of ensuring the propagation and growth of various species of trees adapted to local climatic conditions. Furthermore, a diagnostic study to evaluate the current state of early warning systems was conducted with the national meteorological service, with the aim of including extreme heat in future warnings. In addition, educational and participatory events were held during the hot Canicular period to raise community awareness about climate change and heatwaves, emphasizing the impacts of extreme heat on human health. Students and the general population were trained to adopt adaptation measures to address this threat.

In Medan City and Surabaya City, Indonesia, the project identified a lack of recognition that extreme heat is an urgent issue, both by the central and local governments. Given the tropical nature of the country's climate, "heatwave" was not an appropriate term for the heat in Indonesia, rather terms like "heat stress" and "extreme heat" better resonated with the tropical, long-term, hot temperatures that people experienced. Through collaborative efforts with key stakeholders, several workshops were delivered on extreme heat to share knowledge and data to address this gap. The outcome was an agreement to conduct a scientific national-level study on extreme heat risks led by the Meteorology, Climatology, and Geophysics Agency to understand and address health, economic and labour impacts, fostering dialogue and sharing best practices.

The Tanzania Red Cross Society (TRCS), in collaboration with Ardhi University and the Zanzibar Climate Change Alliance, composed a municipality-level GIS base map in the cities of Tanga (Tanzania) and Unguja (Zanzibar). The study focused on 20 wards in the most-affected areas by disasters, including extreme heat. The findings encompassed changes observed in various parameters, involving land use patterns, encroachment of the transport system, temperatures and humidity from 1982 to date. The maps can assist in strategic planning, resource utilization management, the organization of day-to-day operations and the preparation of municipality-level disaster and climate risk mitigation planning.

HONDURAS RED CROSS GIVING A LESSON IN HEAT RISKS AND ACTIONS TO SCHOOL STUDENTS ON HEAT ACTION DAY 2024. (HONDURAS RED CROSS)

LONG-TERM ADAPTATION SOLUTIONS CAN PREPARE SOCIETIES FOR THE INCREASED FREQUENCY, DURATION AND INTENSITY OF HEATWAVES

Long-term adaptation measures are also key to addressing the impact of stronger and more frequent heatwaves. As cities continue to grow rapidly, especially in Africa and Asia, it's critical that this growth incorporates planning for extreme heat, rather than building in higher exposure and vulnerability to heat. This growth presents both an important opportunity and a potential risk. The World Bank states that adapting infrastructure to become more climate resilient has a cost–benefit ratio of about 4:1 in developing countries, so an investment of one trillion US dollars in infrastructure resilience would leverage 4.2 trillion US dollars in benefits.[85]

Nature-based solutions or green and blue infrastructure investments can offer important modifications to the built environment and lead to opportunities to build new structures that are resilient to extreme heat (and other threats). A systematic review of literature provided evidence of the benefits of blue-green-grey infrastructure, such as the introduction of parks and engineered greening in cities, on temperature decreases. In cities, the review noted substantial reductions in temperature[86] and other related co-benefits: in botanical gardens between 5°C and 3.5°C; in wetlands between 4.9°C and 3.2°C; of street trees between 3.8°C and 3.1°C; of green walls between 4.1°C and 4.2°C; and of vegetated balconies between 3.8°C and 2.7°C.

These modifications can transform public spaces, such as streets and squares, into shaded areas to reduce the urban heat island effect. Examples include urban forests, green roofs and walls, cool pavements, permeable surfaces, parks and wetlands, water bodies, and sustainable urban drainage systems.[87] The most popular building-related strategies in low-income / high exposure settings, e.g. informal settlements and business areas are mechanical cooling (e.g. fans), light curtains and energy-saving bulbs as well as door nets, wall/roof insulation and lighter colouring for

STUDENTS PARTICIPATING IN A KNOWLEDGE FAIR ON HEAT HEALTH RISKS IN HONDURAS. (HONDURAS RED CROSS)

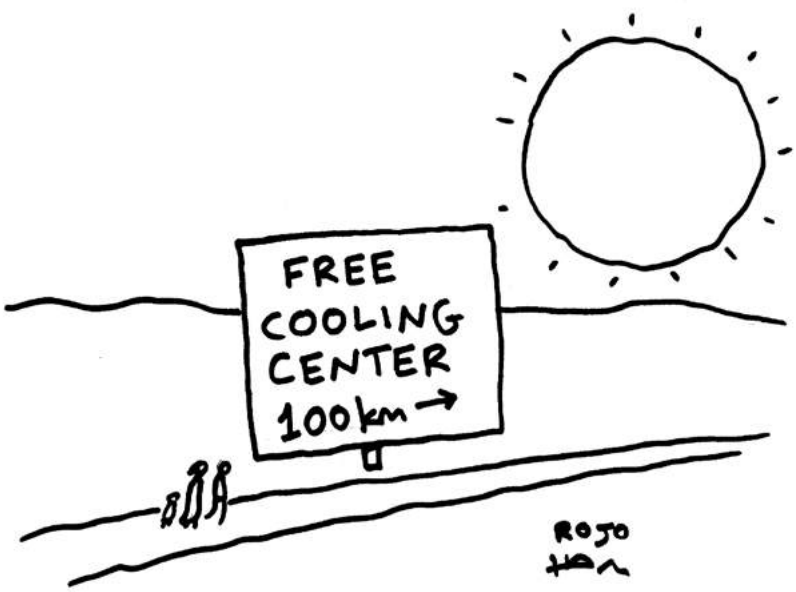
roofs and pavements.[88] Existing urban planning tools, such as building codes and city masterplans should be used in this process.[83]

Passive cooling interventions for buildings are an effective, traditional solution which is disappearing in many parts of the world due to rapid and unplanned urbanization. These interventions influence the building envelope – the physical separator between the conditioned and unconditioned environment (e.g. exterior walls, foundations, roof, windows).[89] For example, Mediterranean and Latin American-style courtyards are designed to maximize a building's thermal mass and shade inside the courtyard and generate a cooling effect.[90]

In the Netherlands local authorities are taking structural heat adaptation measures through a so-called Heat Adaptation Menu for the key sectors: health, housing and habitat. This approach offers guidance and tools for municipalities to address heat risks in their built environment.[91]

A VOLUNTEER FOR THE BANGLADESH RED CRESCENT CHECKS ON A WOMAN AND HER BABY AT A COOLING STATION SET UP BY THE RED CRESCENT IN DHAKA, BANGLADESH. INFANTS ARE PARTICULARLY SUSCEPTIBLE TO EXTREME HEAT AND SIDE EFFECTS SUCH AS DEHYDRATION. (BANGLADESH RED CRESCENT)

LEAVING NO ONE BEHIND



Heat interventions, like the ones mentioned in this report, need to be targeted to the groups who are disproportionately impacted (e.g. elderly, disabled, chronically ill, homeless people, pregnant and lactating women and babies). Yet, Heat Action Plans and Early Warning Systems often have gaps that make them inaccessible for the very populations they should serve. During the development of these measures, it is key to ensure that vulnerable groups are involved through participatory co-creation processes and that their exposure to heat is well understood and addressed. We cannot set up cooling shelters without providing people with transportation to reach them. We cannot send early warnings in languages that people do not understand. We cannot ask outdoor workers to stop working in the heat without compensating their wages. Targeted actions need to closely align with the lived realities that people face.

Proven, low-cost measures exist, but their success depends on coordinated, cross-sector collaboration from the national to local levels. National meteorological services, government departments, health and social services, urban planners, the private sector and communities must work together. Crucially, vulnerable populations must be at the centre of inclusive planning processes to ensure their specific needs are recognized and addressed.

BANGLADESH RED CRESCENT VOLUNTEERS SHARING MESSAGES OF HEAT SAFETY USING A LOUDSPEAKER MOUNTED ON A THREE-WHEELER. (BANGLADESH RED CRESCENT)

GOVERNMENTS AND DECISION-MAKERS ARE UNDERESTIMATING THE THREAT OF EXTREME HEAT, EVEN AS PUBLIC CONCERN RISES

Chapter 6

Extreme heat has inequitable impacts across social, economic and urban environmental systems. It is one of the most pervasive and deadly climate risks, yet it remains one of the most under-prioritized in policy and planning. Although awareness of heat-related risks is growing, the planning and governance systems for addressing and managing heat remain less developed and understood compared to those for other climate hazards.[92] While individuals, communities and governments are grappling to adapt to extreme heat, the nature and extent of these adaptations differ significantly, as do the actors involved in promoting and implementing them.

In many countries, extreme heat has only recently begun to be formally recognized as a hazard. For decades, climate action plans have prioritized more visible and episodic threats such as floods, storms or wildfires, which have traditionally received more attention in both emergency response systems and long-term planning. As a result, extreme heat, despite its significant impacts, has been treated as an invisible or secondary issue.

Many communities perceive that policymakers have done little or nothing to address the growing threat of extreme heat.[9] They describe heat as a neglected crisis that is already impacting their lives.

As one resident from Zimbabwe described:

"The government seems to be OK with us burning each year. I think they have come to the conclusion that it's normal and OK for us to experience heat so much that they seem unmoved. Yet we struggle each time from August. In fact, no one has come here to talk about it. You [the research team] are the first to talk to us about this topic." [22]

Another added,

"Here, we are on our own when it comes to extreme heat. We are given support in other things, but not in heat." [22]

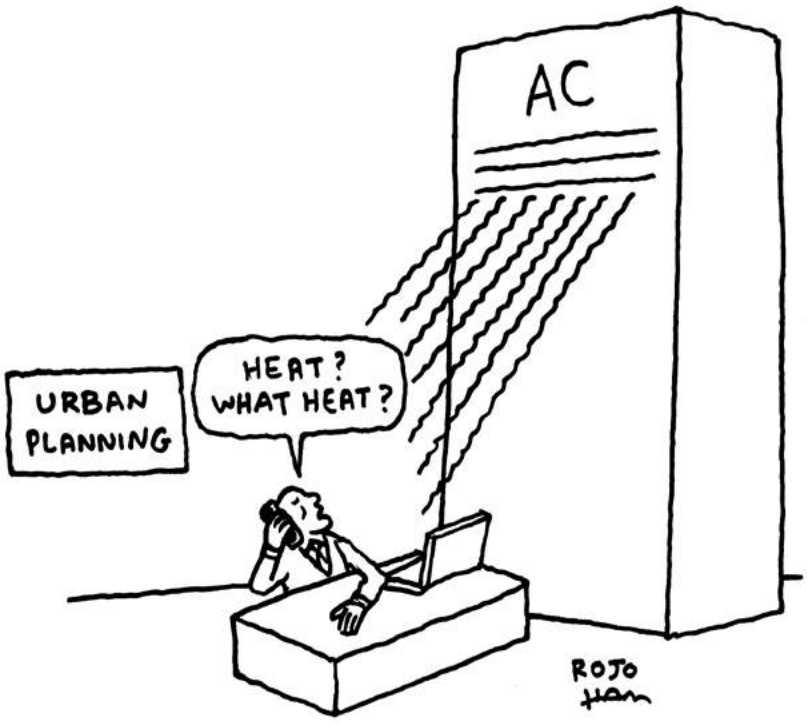
A lack of trust in government support was voiced by a resident in Nepal:

"We have been struggling with the local government for basic needs like drinking water supply... In such a context, we do not expect the government to provide us with any support for heatwave or other such issues." [9]

UNDERSTANDING THE HEAT PERCEPTIONS OF DECISION-MAKERS

Official and expert perceptions of heat-risk have evolved, especially following extreme heatwaves. Historically, authorities in many countries underestimated the severity of extreme heat. For example, in the United Kingdom, heat was not traditionally seen as a major threat and the British public's perceived vulnerability to heat has been relatively low compared to other climate risks.[93] Prior to the 2003 European heatwave, which caused over 70,000 deaths, almost no heat warning systems and action plans existed.

Despite some progress, literature indicates that the prioritization of heat among decision-makers remains inconsistent. There is still very limited research on how decision-makers perceive heat risk, and more studies are urgently needed to understand how perceptions among policymakers, supervisors and municipal officials shape institutional responses. In Brussels and Amsterdam, even stakeholders in the health and social care sectors were unfamiliar with national heatwave plans and ranked heat-risk low among their concerns.[94] Similarly, a study in nine Indian cities found that many local government officials had never seen their Heat Action Plan, and institutional barriers, such as poor coordination, staffing shortages and lack of urgency, were widespread.[95] On the other hand, planning professionals across the United States have expressed concern for extreme heat and reported impacts but also have encountered many barriers related to human and financial resources and political will.[96] In China, bus drivers' managers recognized the risks and supported interventions like air-conditioning and health advice, but budget constraints and lack of clear policies were key barriers to action.[26]



Overall, more research is also needed to understand how those in positions of power, including supervisors, policymakers and municipal officials, perceive heat risk. Their perceptions influence institutional priorities, resource allocation and the seriousness with which adaptation measures are pursued. Addressing these gaps in understanding could be essential for more proactive and equitable governance.

WEAK FOUNDATIONS IN POLICY AND PLANNING

Effective policy must integrate behavioural and social insights, recognizing that individual actions are shaped by access to resources, social norms and levels of trust in authorities.[97] Yet current policy responses to extreme heat remain largely fragmented, underfunded and reactive.

A major barrier is that heat is not consistently recognized as a disaster under disaster legislation. This limits the ability of humanitarian actors to respond. To address heat in a meaningful and effective way, it must be incorporated in a range of different policies – from national climate adaptation strategies and urban planning frameworks to labour laws and social protection systems. For instance, in many countries, current labour laws do not include provisions to protect both indoor and outdoor workers from extreme heat.

GAPS IN HEAT ACTION PLANS

Although Heat Action Plans are becoming more common, many countries around the world still lack any form of HAP and the plans that do exist often contain significant limitations. Existing Heat Action Plans are often underfunded, fragmented or disconnected from broader development and climate agendas. Reviews of existing HAPs around the world point out a number of gaps that are common to this vital policy mechanism employed to battle heat risk across contexts. This includes the fact that these tend not to include the optimal level of climate analysis and overlook socioeconomic factors that play a vital role in determining heat risk.[98] In India, for example, HAPs tend to have weak legal foundations (i.e. their operationalization cannot be enforced); they are not transparent (i.e. there is no consolidated repository, many are not online and it is not clear if and how they are updated); furthermore, HAPs tend to operate in sectoral silos and focus mostly on the health sector as opposed to providing a vision of the cross-sectoral, systems change that is essential for tackling heat risk at scale and sustainably.[76]

URBAN PLANNING AND LONG-TERM ADAPTATION

An analysis of five cities in the United States found that, while elements of heat planning were incorporated across various municipal plans, only a limited number of strategies addressed heat explicitly as a central issue, indicating a missed opportunity to align heat mitigation more closely with broader policy goals.[92] The study also observed that urban planners often played a secondary role compared to other professional groups, despite the critical importance of urban planning in addressing heat-related inequities. Strengthening the integration of urban planning within broader governance frameworks could enhance policymakers' capacity to implement effective heat mitigation and management strategies. While research provides evidence that cities are expanding their climate adaptation planning,[99] it also demonstrates how urban heat is a critical, yet underdeveloped aspect of local governance.[92]

OCCUPATIONAL HEAT RISK

Heat stress in the workplace is another critical governance gap. Occupational heat stress, including seasonal labour, is a huge concern globally. According to the International Labour Organization (ILO), approximately 2.41 billion workers – which is 71 per cent of the global workforce – are exposed to extreme heat.[100] ILO indicates that in regions like Africa, the Arab States and the Asia Pacific, this exposure exceeds the global average, reaching up to 92.9 per cent in Africa. In extreme poverty-stricken areas, outdoor workers often have lesser abilities to adapt to heat and face hardship due to loss of income.

"Many vendors asked the other members of their households to stay at home out of heat-related health concerns. Even though they would have preferred to take heatwave days off but could not afford it, due to financial responsibilities." [8]

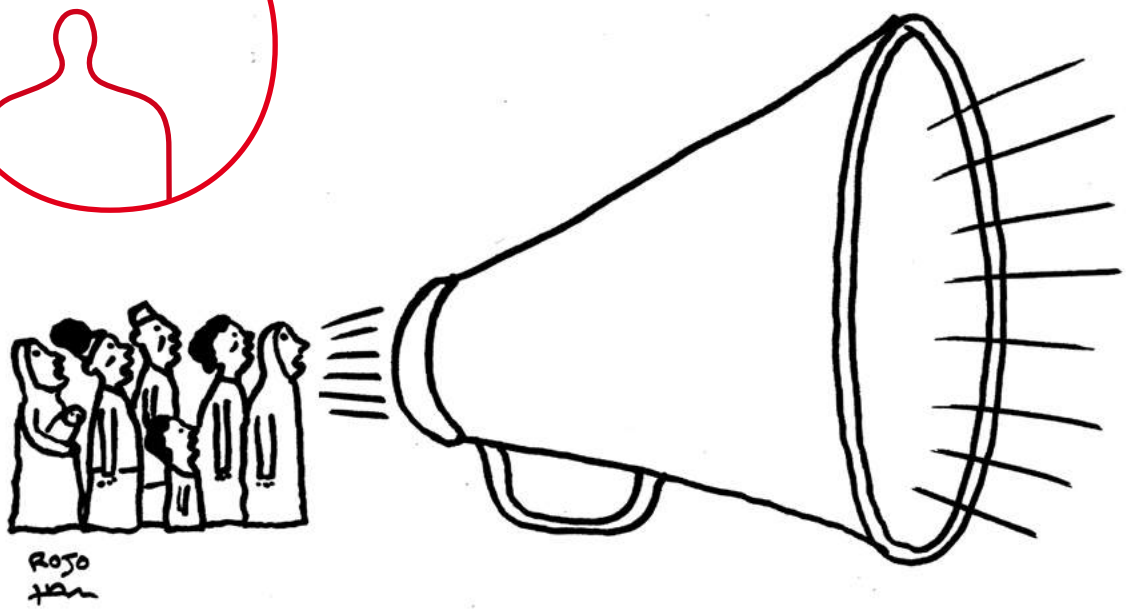
The current state of heat policy and governance reveals substantial gaps within existing occupational safety and health (OSH) frameworks, which often fail to adequately address the growing risks associated with extreme heat. Although several countries are beginning to revise legislation or introduce regulations targeting workplace heat stress, policy responses remain fragmented and inconsistent across regions, leading to measures that frequently fall short of effectively protecting workers' health and safety.[101] Effective governance in this area necessitates coordinated action among governments, employers and workers' organizations to develop evidence-based, sector-specific strategies.

TOWARDS MORE EFFECTIVE AND EQUITABLE GOVERNANCE

Despite emerging initiatives, significant challenges persist, underscoring the urgent need for more comprehensive and cohesive approaches. Research shows that key barriers to municipal heat planning include limited funding, time constraints, staffing shortages, competing policy priorities, leadership gaps and insufficient public support.[90] In many cities, urban planning measures that could significantly reduce heat exposure, such as redesigning the built environment and reformulating building codes to promote heat resilience, remain secondary to short-term emergency responses. Where efforts do exist, they often fail to reach the most vulnerable people, particularly residents of informal settlements. In developing countries, where informal neighbourhoods account for 20–80 per cent of urban populations and are projected to house nearly 3.1 million people globally by 2050,[102] these gaps in protection are particularly acute.

Addressing these gaps demands a shift towards intersectional policies that are both inclusive and locally grounded. Top-down approaches alone are insufficient; heat adaptation must centre local knowledge, locally led adaptation solutions, and participatory governance. Only by embedding equity considerations into urban planning, infrastructure investment and social protection strategies can governments meaningfully reduce the disproportionate burden of heat on vulnerable populations and ensure that resilience efforts leave no one behind. The scale and urgency of the heat challenge demands a whole-of-society response.

CONCLUSION: A COLLECTIVE CALL TO ACTION



People, communities and governments must demand a whole-of-society approach to tackle the wide-reaching, detrimental impacts of extreme heat. This includes recognizing heat risk and its threat to human health and well-being, bolstering protective systems to meet rising demands, addressing policy, planning and governance gaps and recognizing the cascading and compounding impacts of extreme heat across sectors in the near- and long-term. Drawing on risk perception surveys and academic literature from around the world, we issue the following call to action:

1:

RECOGNIZE THAT HEAT-RISK EXISTS, IS ON THE RISE DUE TO CLIMATE CHANGE, AND IS THREATENING HUMAN HEALTH AND WELL-BEING

Listen to people's experience with extreme heat and help them to understand its dangers. Close gaps in health surveillance and reporting to better understand, address and track progress towards reducing heat–health impacts, including deaths. Invest in research and policy to address the mental health impacts of extreme heat. Address indoor heat-risk via a mosaic of solutions including building codes, social assistance programmes, public messaging and scaling health and social services. Invest in child protection measures to ensure education disruptions are minimized.

2: ENSURE HEAT-RISK MESSAGING IS INCLUSIVE, TARGETED AND ADDRESSES SOCIO-PSYCHO-LOGICAL DRIVERS

Scale investments in targeted heat-risk communication to bridge the gap between meteorological information and life-saving protective actions. Develop and deploy heat risk communication that is people-centred, context-aware, action-oriented and rooted in behavioural science. Ensure messages are communicated through a variety of channels, formats and languages to increase accessibility. Include visual communication to reach people across literacy and language barriers.

3: WORK TO REMOVE THE PRACTICAL, SOCIAL AND FINANCIAL BARRIERS THAT PREVENT HEAT ACTION

Drive funding to the local level to improve access to adequate housing, electricity supply and clean water. Enhance access to emergency services by ensuring people have low- or no-cost health and cooling options, nearby and without social barriers.

Ensure labour protections exist, are enforced and are extended to workers in both the formal and informal economy. Labour protections must include the right to rest breaks, adjusted work hours, water access and first aid knowledge. These protections must also be grounded in equity and justice while accounting for unique forms of vulnerability such as age, health conditions and gender. Social safety net programmes should include extreme heat provisions; for example, supplemental income so workers have a viable path to avoid putting themselves in harm's way.

4: SCALE HEAT ACTION PLANS AND HEAT EARLY WARNING SYSTEMS

Scale multi-sectoral and multi-stakeholder heat action plans that reduce heat-risk across the immediate to long-term. Ensure every country has a robust heat–health early warning system in place and close gaps in heat-risk surveillance. Ensure heat action plans and early warning systems account for unique forms of vulnerability, such as internally displaced people, people in informal settlements, people who are homeless, people in refugee camps, people with mobility challenges, older populations and people with pre-existing health conditions, among others.

5: 6: 7:

INCORPORATE HEAT INTO URBAN PLANNING AND DESIGN

As cities grow, future risk is predicated on how well heat-risk management solutions are integrated into urban planning, zoning and design. Incorporate blue and green infrastructure, building codes for passive and active cooling, and design social infrastructure and public spaces that can double as cooling centres or cool spaces. Investments in finance need to scale up quickly to respond to the growing risk, requiring innovative financing mechanisms.

PLAN FOR CASCADING AND COMPOUNDING IMPACTS ACROSS SECTORS DURING EXTREME HEAT EVENTS

Plan for a surge in electricity demand during extreme heat events to prevent power outages and load shedding that can, in turn, lead to cascading impacts on health, food and economic systems. Plan for the compounding effects of extreme heat and air pollution that can further exacerbate health conditions and increase demand on emergency health services. Consider other unique situations of heightened exposure such as extreme heat following hurricane destruction, or extreme heat in conflict settings – where protective systems are often highly eroded.

URGENTLY ADDRESS HEAT GOVERNANCE AND POLICY NEEDS

Political leaders and decision-makers need to acknowledge and work to address extreme heat concerns with clear ownership in relevant agencies and departments, and communities must be engaged in decision-making. A whole-of-society approach must include integrating extreme heat considerations into worker safety legislation, social protection policies, utility regulations, climate policies, urban planning and design, and development plans. Extreme heat must also be codified in disaster law to unlock emergency response funding. Policies must address near- and long-term concerns and must reinforce each other across levels to reduce barriers to action.

METHODOLOGY

This report uses a mixed-methods approach that integrates scientific literature, expert insights and community risk perception data to explore the impacts of extreme heat. Central to this approach is the incorporation of findings from heat-risk perception surveys conducted across diverse global regions, with a particular emphasis on developing countries where research on heat impacts has historically been limited. By combining peer-reviewed evidence with qualitative narratives and firsthand accounts, the report aims to record bottom-up perspectives on extreme heat. Special attention is given to areas of convergence between community experiences and academic consensus, as well as to points of divergence that reveal gaps in current understanding. This approach enables a more nuanced view of heat-risk and supports the identification of emerging issues requiring further research and policy attention.

The report primarily references risk perception surveys conducted by Red Cross and Red Crescent National Societies in cities, including the Honduras Red Cross Society, Indonesian Red Cross Society, Nepal Red Cross Society and Tanzania Red Cross Society. Each of these research studies are being prepared for publishing at the time of writing this report. This work was funded by USAID, the British Red Cross and the Quadrature Climate Foundation. It also incorporates risk perception research undertaken as part of a small research grants programme organized by the Global Disaster Preparedness Center of the American Red Cross and IFRC, the Climate Centre and the Global Heat Health Information Network. Through this programme, risk perception research was published from countries where there has been a gap in this type of research including in Ghana, Guatemala, India, Indonesia, Nepal, Uganda and Zimbabwe. This work was also funded by the American Red Cross.

ENDNOTES

1 Intergovernmental Panel on Climate Change. ***AR6 Synthesis report: Climate change 2023.*** https://www.ipcc.ch/report/sixth-assessment-report-cycle/

2 Arrighi, J., Otto, F.E.L., Marghidan, C.P., Philip, S., Singh, R., Vahlberg, M., Giguere, J., Pershing, A.J., Tannenbaum, A., & Veitch, A. ***Climate change and the escalation of global extreme heat: Assessing and addressing the risks, 2024.*** https://assets.ctfassets.net/cxgxgstp8r5d/5sjPWtBWuPk56xVZKuuL3g/fe050dd8d61e8b2a7e3a315a4b75b22f/Climate_Change_and_the_Escalation_of_Global_Extreme_Heat_Climate_Central.pdf

3 World Weather Attribution. ***Women and girls continue to bear disproportionate impacts of heatwaves in South Sudan that have become a constant threa***t, 2025. https://www.worldweatherattribution.org/women-and-girls-continue-to-bear-disproportionate-impacts-of-heatwaves-in-south-sudan-that-have-become-a-constant-threat/

4 McSweeney, R. & Tandon, A. Mapped: *How climate change affects extreme weather around the world*, 2024. https://interactive.carbonbrief.org/attribution-studies/

5 Philip, S.Y., Kew, S.F., van Oldenborgh, G.J. et al. 'Rapid attribution analysis of the extraordinary heat wave on the Pacific coast of the US and Canada in June 2021', *Earth System Dynamics* 13, 1689–1713, 2022. https://doi.org/10.5194/esd-13-1689-2022

6 World Weather Attribution. *Extraordinary March heatwave in Central Asia up to 10°C hotter in a warming climate*, 2025. https://www.worldweatherattribution.org/wp-content/uploads/WWA-scientific-report-West-Asia-heat.pdf

7 Jones, L. & d'Errico, M. 'Whose resilience matters? Like-for-like comparison of objective and subjective evaluations of resilience', *World Development*,124, 2019. https://www.sciencedirect.com/science/article/pii/S0305750X19302803

8 Kotharkar, Dr. R., Rajopadhye, S. & Shaw, S. *Extreme heat risk among informal sector workers based on perception and micrometeorological field study*, 2022. https://preparecenter.org/wp-content/uploads/2022/12/India-Heat-Perceptions-Research-by-R.Kotharkar-2022.pdf.

9 Nepal Red Cross Society. *Heat risk perception study – Nepal*. (In progress).

10 Ziblim, S.-D., Mogre, V., Kpebu, S.E.A. et al. 'Public perception of the health and social risks of extreme heat in northern Ghana', *Research Gate* 1–36, 2022. doi:10.13140/RG.2.2.25247.53927

11 Indonesian Red Cross Society. *Heat risk perception study – Indonesia*. (In progress).

12 Hauger, S. *Perceptions of climate change in China: The research and policy connection. Sciences in Cold and Arid Regions*, 2014. https://www.academia.edu/6909303/Perceptions_of_climate_change_in_China_The_research_and_policy_connection

13 Zhao, Q., Guo, Y., Ye, T. et al. 'Global, regional, and national burden of mortality associated with non-optimal ambient temperatures from 2000 to 2019: A three-stage modelling study', *Lancet Planetary Health* 5, e415–e425, 2021. doi: 10.1016/S2542-5196(21)00081-4

14 Green, H., Bailey, J., & Schwarz, L. et al. 'Impact of heat on mortality and morbidity in low and middle income countries: A review of the epidemiological evidence and considerations for future research', *Environmental Research* 171, 80–91, 2019. DOI: 10.1016/j.envres.2019.01.010

15 Mora, C., Dousset, B. & Caldwell, I.R. et al. 'Global risk of deadly heat', *Nature Climate Change* 7, 501–506, 2017. https://doi.org/10.1038/nclimate3322

16 McElroy, S., Ilango, S., Dimitrova, A., Gershunov, A. & Benmarhnia, T. 'Extreme heat, preterm birth, and stillbirth: A global analysis across 14 lower-middle income countries', *Environment International* 158, 106902, 2022. https://doi.org/10.1016/j.envint.2021.106902

17 Cianconi, P., Betrò, S. & Janiri, L. 'The impact of climate change on mental health: A systematic descriptive review', *Frontiers in Psychiatry* 11, 2020. https://doi.org/10.3389/fpsyt.2020.00074

18 Rony, M.K.K. & Alamgir, H.M. 'High temperatures on mental health: Recognizing the association and the need for proactive strategies – A perspective', *Health Science Reports* 6, e1729, 2023. https://doi.org/10.1002/hsr2.1729

19 Thompson, R., Lawrance, E.L., Roberts L.F. et al. 'Ambient temperature and mental health: A systematic review and meta-analysis', *Lancet Planetary Health* 7, e580–e589, 2023. https://www.thelancet.com/journals/lanplh/article/PIIS2542-5196(23)00104-3/fulltext

20 Nori-Sarma, A., Sun, S., Sun, Y. et al. 'Association between ambient heat and risk of emergency department visits for mental health among US adults, 2010 to 2019', *JAMA Psychiatry* 79, 341–349, 2022. https://jamanetwork.com/journals/jamapsychiatry/fullarticle/2789481

21 Burke, M., González, F. & Baylis, P. et al. 'Higher temperatures increase suicide rates in the United States and Mexico', *Nature Climate Change* 8, 723–729, 2018. https://www.nature.com/articles/s41558-018-0222-x

22 Romanello, M., Walawender, M., Hsu, S.-D. et al. 'The 2024 report of the Lancet Countdown on health and climate change: Facing record-breaking threats from delayed action', *The Lancet* 404, 1847–1896, 2024. https://www.thelancet.com/journals/lancet/article/PIIS0140-6736(24)01822-1/abstract

23 Obradovich, N., Migliorini, R., Mednick, S.C. & Fowler, J.H. 'Nighttime temperature and human sleep loss in a changing climate', *Science Advances* 3, e1601555, 2017. DOI: 10.1126/sciadv.1601555

24 Baysan, C., Burke, M., González, F., Hsiang, S. & Miguel, E. 'Non-economic factors in violence: Evidence from organized crime, suicides and climate in Mexico', *Journal of Economic Behavior and Organization* 168, 434–452, 2019. https://doi.org/10.1016/j.jebo.2019.10.021

25 Chadambuka, P., Moyo, T. & Bhatasara, S. *Beitbridge residents' perceptions of extreme heat*, 2022. https://preparecenter.org/wp-content/uploads/2022/12/Zimbabwe-Heat-Perceptions-research-by-P.-Chadambuka-2022.pdf.

26 Zhou, L., Xin, Z., Bai, L. et al. 'Perceptions of heat risk to health: A qualitative study of professional bus drivers and their managers in Jinan, China', *International Journal of Environmental Research and Public Health* 11, 1520–1535, 2014. https://www.mdpi.com/1660-4601/11/2/1520

27 Bogdanovich, E. Brenning, A., Reichstein, M. et al. 'Official heat warnings miss situations with a detectable societal heat response in European countries', *International Journal of Disaster Risk Reduction* 100, 104206, 2024. https://doi.org/10.1016/j.ijdrr.2023.104206

28 Campbell, S., Remenyi, T.A., White, C.J. & Johnston, F.H. 'Heatwave and health impact research: A global review', *Health & Place* 53, 210–218, 2018. DOI: 10.1016/j.healthplace.2018.08.017

29 Adams, Q. H., Sun, Y., Sun, S. & Wellenius, G.A. 'Internet searches and heat-related emergency department visits in the United States', *Scientific Reports* 12, 9031, 2022. https://www.nature.com/articles/s41598-022-13168-3

30 Sseviiri, H., Mukwaya P.I., Twinomuhangi, R. et al. *Heat risk perception and communication strategies for adaptation within low-income communities in Kampala City, Uganda*, 2022. https://preparecenter.org/wp-content/uploads/2022/12/Uganda-Heat-Perceptions-Research-by-H.Sseviiri-2022.pdf

31 Joshi, A., Marasini, S., Sharma, S., Man Karmachary, B. & Timsina, L. *Knowledge, attitudes, practice & risk perceptions regarding heatwave among outdoor workers in Nepal,* 2022. https://preparecenter.org/wp-content/uploads/2022/12/Nepal-Heat-Perceptions-Research-by-A.Joshi-2022.pdf.

32 Honduras Red Cross Society. *Heat risk perception study – Honduras.* (In progress).

33 Batur, I., Alhassan, V.O., Chester, M.V. et al. 'Understanding how extreme heat impacts human activity-mobility and time use patterns', *Transportation Research Part D: Transport and Environment* 136, 104431, 2024. https://doi.org/10.1016/j.trd.2024.104431

34 Fan, Z. & Zhou, X. 'Decoding the role of extracellular polymeric substances in enhancing nitrogen removal from high-ammonia and low-C/N wastewater in a sequencing batch packed-bed biofilm reactor', *Polymers* 15, 1510, 2023. doi: 10.3390/polym15061510

35 Zhang, Y., Wang, D., Liu, Y. et al. 'Urban food delivery services as extreme heat adaptation', *Nature Cities* 2, 170–179, 2025. https://doi.org/10.1038/s44284-024-00172-z

36 World Weather Attribution. *Climate change made the deadly heatwaves that hit millions of highly vulnerable people across Asia more frequent and extreme,* 2024. https://www.worldweatherattribution.org/climate-change-made-the-deadly-heatwaves-that-hit-millions-of-highly-vulnerable-people-across-asia-more-frequent-and-extreme/

37 Save the Children International. *South Sudan: Heatwave forces schools to shut for second year running*, 2025. https://www.savethechildren.net/news/south-sudan-heatwave-forces-schools-shut-second-year-running

38 UNICEF. *The climate-changed child*, 2023. https://www.unicef.org/reports/climate-changed-child

39 Kafeety, A., Henderson, S.B., Lubik, A. et al. 'Social connection as a public health adaptation to extreme heat events', *Canadian Journal of Public Health / Revue canadienne de santé publique* 111, 876–879, 2020. https://doi.org/10.17269/s41997-020-00309-2

40 Klinenberg, E. *Heat Wave: Social autopsy of disaster in Chicago,* University of Chicago Press, 2002. https://www.bibliovault.org/BV.landing.epl?ISBN=9780226026718

41 Ministry of Power. *Power sector at a glance – All India.* Government of India, Ministry of Power, 2023. https://powermin.gov.in/en/content/power-sector-glance-all-india

42 Alcayna, T., Chandaria, S., Kim, J., O'Donnell, D. & Poole, L. *Understanding the compound risk of heat, humidity and air pollution on human health: A scoping review,* 2023. https://www.climatecentre.org/wp-content/uploads/RCCC-Heat-Humidity-AP-Scoping-Review-Final-4.pdf

43 Sidhu, B.S. 'Likely impacts of the 2022 heatwave on India's wheat production', *Environmental Research Letters* 18, 105001, 2023. DOI 10.1088/1748-9326/acf871

44 Hass, A.L., Runkle, J.D. & Sugg, M.M. 'The driving influences of human perception to extreme heat: A scoping review' *Environmental Research* 197, 111173, 2021. https://doi.org/10.1016/j.envres.2021.111173

45 McLoughlin, N., Howarth, C. & Shreedhar, G. 'Changing behavioral responses to heat risk in a warming world: How can communication approaches be improved?', *WIREs Climate Change* 14, e819, 2023. https://doi.org/10.1002/wcc.819

46 Venugopal, V. & Lahta, P. *How do workers perceive heat, heavy workload, dehydration and lack of access to sanitation as risk factors for chronic kidney disease? – Surveying from different occupational groups in South India,* 2022. https://preparecenter.org/wp-content/uploads/2022/12/India-Heat-Perceptions-Research-by-PK.-Lahta-2022.pdf

47 Dunlap, L. *Communicating heat risk: A guide to inclusive, effective, and coordinated public information campaigns*, 2024. https://www.cakex.org/documents/communicating-heat-risk-guide-inclusive-effective-and-coordinated-public-information-campaigns

48 Heidenreich, A. & Thieken, A.H. 'Individual heat adaptation: Analyzing risk communication, warnings, heat risk perception, and protective behavior in three German cities', *Risk Analysis* 44, 1788–1808, 2024. https://doi.org/10.1111/risa.14278

49 Global Heat Health Information Network. *Communicating heat health warnings and heat related information to stakeholders and the public*, 2024. https://ghhin.org/communicate/

50 Goulding, R. *Extreme heat events: Media communication with impact,* 2025. https://ncceh.ca/sites/default/files/2025-05/NCCEH%20Extreme%20Heat%20Media%20Engagement%20Public%20Report%20Draft%2007MAY2025.pdf

51 O'Neill, S., Hayes, S., Strauβ, N. et al. 'Visual portrayals of fun in the sun in European news outlets misrepresent heatwave risks', *The Geographical Jornal* 189, 90–103, 2023. DOI: 10.1111/geoj.12487

52 European Commission. *Harmonized approach to stress tests for critical infrastructures against natural hazards,* 2016. https://cordis.europa.eu/project/id/603389/reporting

53 Global Heat Health Information Network. *Managing heat risk during the COVID-19 pandemic*, 2020. https://ghhin.org/resources/checklist-managing-heat-risk-during-the-covid-19-pandemic-2/

54 Beckmann, S.K., Hiete, M., Schneider, M. & Beck, C. 'Heat adaptation measures in private households: An application and adaptation of the protective action decision model', *Humanities & Social Sciences Communications* 8, 1–12, 2021. https://www.nature.com/articles/s41599-021-00907-6.pdf

55 World Health Organization, 2024. *Heat and health*. https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

56 World Weather Attribution. *Extreme Sahel heatwave that hit highly vulnerable population at the end of Ramadan would not have occurred without climate change*, 2024. https://www.worldweatherattribution.org/extreme-sahel-heatwave-that-hit-highly-vulnerable-population-at-the-end-of-ramadan-would-not-have-occurred-without-climate-change/

57 Subedi, A., Islam, T., Khan, R., Hassan, D. A. & Hogesteeger, S. *Identification of heat threshold and heat hotspots in Rajshahi*, Bangladesh, 2022. https://www.anticipation-hub.org/Documents/Reports/RCCC_Heat_treshold_Rajshani_V5.pdf

58 Tuholske, C. Lynch, V.D., Spriggs, R. et al. 'Hazardous heat exposure among incarcerated people in the United States', *Nature Sustainability* 7, 394–398, 2024. https://www.nature.com/articles/s41893-024-01293-y

59 Brunn, K., Toledo, O., Tran, C.C., Vasudevan, A. & Venkat, B.J. 'Carceral heat exposure as harmful design: An integrative model for understanding the health impacts of heat on incarcerated people in the United States', *Social Science & Medicine* 367, 117679, 2025. https://doi.org/10.1016/j.socscimed.2025.117679

60 Meerkotter, A. *Climate change and prisons in SADC,* 2025. https://africanlii.org/articles/2025-03-06/SALC/climate-change-and-prisons-in-sadc.

61 Collectif des Organisations de Défense des Droits de L'Homme et de la Démocratie. *Rapport sur la situation des droits de l'homme en milieu carceral au Niger,* 2014.

62 Bussolo, M. & Sharma, S. *Hidden potential rethinking informality in South Asia*, 2022. https://www.worldbank.org/en/region/sar/publication/hidden-potential-rethinking-informality-in-south-asia

63 Kim, E., Henry, G. & Jain, M. *Urban heat in South Asia: Integrating people and place in adapting to rising temperatures*, 2023. https://weadapt.org/knowledge-base/cities-and-climate-change/urban-heat-in-south-asia-integrating-people-and-place-in-adapting-to-rising-temperatures/

64 Global Commission on Adaptation. *State and trends in climate adaptation finance 2024.* https://gca.org/wp-content/uploads/2024/04/State-and-Trends-in-Climate-Adaptation-Finance-2024.pdf

65 United Nations Environment Programme. *Adaptation gap report 2023.* https://www.unep.org/resources/adaptation-gap-report-2023

66 Naran, B., Buchner, B., Price, M., Stout, S. & Taylor, M. *Global landscape of climate finance* 2024. https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2024/

67 Green Climate Fund. *FP177: Cooling facility*, 2021. https://www.greenclimate.fund/project/fp177

68 Global Environment Facility. *UN and partners launch billion-dollar initiative to transform cities for people and planet.* https://www.thegef.org/newsroom/press-releases/un-and-partners-launch-billion-dollar-initiative-transform-cities-people

69 Japan International Cooperation Agency. *Announcing the Climate Resilience Financing Action Agenda, with a focus on extreme heat, with the U.S. Department of the Treasury, USAID, and multilateral development banks: Recognizing extreme heat as a development challenge and promoting climate-resilient development,* 2025. https://www.jica.go.jp/english/information/press/2024/20250116_21.html

70 State Capitol. *Governor's Budget Summary 2025–26*, 2025.

71 Shekhar, S., Dalal, T., Santhosh, A., Pillai, V. & Krishna, B. *Finding the finance: A guide to identifying centrally sponsored schemes to fund heat resilience solutions*, 2023. https://cprindia.org/workingpapers/finding-the-finance-a-guide-to-identifying-centrally-sponsored-schemes-to-fund-heat-resilience-solutions/

72 Sikka, A. & Padmanabhi, R. *Financing India's heat resilience*, 2024. https://www.climatepolicyinitiative.org/financing-indias-heat-resilience/

73 Margosa, N. & David, D. *Beyond a checklist: Why intersectionality matters in climate change*, 2025. https://centreforpublicimpact.org/resource-hub/beyond-a-checklist-why-intersectionality-matters-in-climate-adaptation/

74 World Health Organization. *Heat and health in the WHO European region: Updated evidence for effective prevention*, 2021. https://iris.who.int/bitstream/handle/10665/339462/9789289055406-eng.pdf

75 Climate Adapt. *Heat health action plans*, 2018. https://climate-adapt.eea.europa.eu/en/metadata/adaptation-options/heat-health-action-plans

76 Pillai, A., Dalal, T., Kukretti, I. et al. *Is India ready for a warming world?*, 2025. https://www.sustainablefutures.org/publication/is-india-ready-for-a-warming-world-how-heat-resilience-measures-are-being-implemented-for-11-of-indias-urban-population-in-some-of-its-most-at-risk-cities/

77 Subedi, A., Khan, R., Hassan, Dr. A. & Hogesteeger, S. *Identification of heat threshold and heat hotspots in Nepalgunj, Nepal*, 2011. https://ghhin.org/resources/identification-of-heat-threshold-and-heat-hotspots-in-nepalgunj-nepal/, https://ghhin.org/resources/identification-of-heat-threshold-and-heat-hotspots-in-nepalgunj-nepal/

78 Coughlan de Perez, E., van Aalst, M., Bischiniotis, K. et al. 'Global predictability of temperature extremes', *Environmental Research Letters* 13, 054017, 2018. DOI 10.1088/1748-9326/aab94a

79 World Meteorological Organization. *Early warnings for all advances but new challenges emerge,* 2014. https://wmo.int/news/media-centre/early-warnings-all-advances-new-challenges-emerge

80 World Meteorological Organization. *2023 State of climate services: Health*, 2023. doi:10.18356/9789263113351

81 McGregor, G. R., Bessemoulin, P., Ebi, K. & Menne, B. *Heatwaves and health: Guidance on warning-system development,* 2015. https://cdn.who.int/media/docs/default-source/climate-change/heat-waves-and-health---guidance-on-warning-system-development.pdf?sfvrsn=e4813084_2&download=true

82 Ballester, J., Quijal-Zamorano M., Méndez Turrubiates, R.F. et al. 'Heat-related mortality in Europe during the summer of 2022'. *Nature Medicine* 29, 1857–1866, 2023. https://www.nature.com/articles/s41591-023-02419-z

83 Arrighi, J., Singh, R., Khan, R. et al. *Heatwave guide for cities*, 2019. https://www.climatecentre.org/downloads/files/RCCC%20Heatwave%20Guide%202019%20NS.pdf

84 Anticipation Hub. *A short overview of anticipatory action*, 2023. https://www.anticipation-hub.org/Documents/Briefing/short-overview-of-anticipatory-action.pdf

85 Hallegatte, S., Rentschler, J. & Rozenberg, J. *Lifelines: The resilient infrastructure opportunity*, 2019. https://openknowledge.worldbank.org/entities/publication/c3a753a6-2310-501b-a37e-5dcab3e96a0b

86 Kumar, P. Debele, S.E., Khalili, S. et al. 'Urban heat mitigation by green and blue infrastructure: Drivers, effectiveness, and future needs' *The Innovation* 5, 2024. https://doi.org/10.1016/j.xinn.2024.100588

87 Van Oijstaeijen, W., Van Passel, S. & Cools, J. 'Urban green infrastructure: A review on valuation toolkits from an urban planning perspective', *Journal of Environmental Management* 267, 110603, 2020. https://doi.org/10.1016/j.jenvman.2020.110603

88 Laue, F., Adegun, O. B. & Ley, A. *Heat stress adaptation within informal, low-income urban settlements in Africa*, 2022. doi:https://doi.org/10.3390/su14138182

89 Sun, K., Zhang, W., Zeng, Z. et al. 'Passive cooling designs to improve heat resilience of homes in underserved and vulnerable communities', *Energy and Buildings* 252, 111383, 2021. https://doi.org/10.1016/j.enbuild.2021.111383

90 Ladd, K. & Meerow, S. *Planning for urban heat resilience*, 2022. https://planning-org-uploaded-media.s3.amazonaws.com/publication/download_pdf/PAS-Report-600-r1.pdf

91 Netherlands Enterprise Agency. *Heat adaptation menu,* 2024. https://english.rvo.nl/en/topics/climate-adaptation-built-environment/heat/heat-adaptation-menu

92 Ladd, K., Gabbe, C. J. & Schmidt, E. 'Urban heat governance: Examining the role of urban planning', Journal of *Environmental Policy & Planning* 25, 642–662, 2023. https://doi.org/10.1080/1523908X.2023.2244446

93 Howarth, C., Zamzow, H., McLoughlin, N. & Shreedhar, G. 'Gaps in public perceptions of extreme heat highlight UK's lack of preparedness', *Environmental Science & Policy* 170, 2024. https://doi.org/10.1016/j.envsci.2025.104101

94 van Loenhout, J. A., Rodriguez-Llanes, J. M. & Guha-Sapir, D. 'Stakeholders' perception on national heatwave plans and their local implementation in Belgium and The Netherlands', *International Journal of Environmental Research and Public Health* 13, 11, 2016. doi:10.3390/ijerph13111120

95 Pillai, A. et al. *Guest post: Why action on extreme heat in Indian cities is falling short,* 2025. https://www.carbonbrief.org/guest-post-why-action-on-extreme-heat-in-indian-cities-is-falling-short/

96 Meerow, S. & Keith, L. *Planning for extreme heat: A national survey of US planners,* 2021. https://www.researchgate.net/publication/354707965_Planning_for_extreme_heat_A_national_survey_of_US_planners

97 *Environmental Science & Policy* 157, 103761, 2024. https://doi.org/10.1016/j.envsci.2024.103761

98 Magotra, R., Tyagi, A., Shaw, M. & Raj, V. *Review of Heat Action Plans in India and South Asia,* 2021. https://heathealth.info/resources/review-of-heat-action-plans-in-india-and-south-asia/

99 Shi, L., Chu, E., Anguelovski I. et al. 'Roadmap towards justice in urban climate adaptation research', *Nature Climate Change* 6, 131–137, 2016. https://doi.org/10.1038/nclimate2841

100 International Labour Organization. *Ensuring safety and health at work in a changing climate: Global report,* 2024. https://researchrepository.ilo.org/esploro/outputs/report/Ensuring-safety-and-health-at-work/995361942702676

101 Flouris, A., Azzi, M., Graczyk, H., Nafradi, B. & Scott, N. *Heat at work: Implications for safety and health. A global review of the science, policy and practice,* 2024. https://researchrepository.ilo.org/esploro/outputs/report/Heat-at-work-implications-for-safety/995381672402676

102 United Nations Statistics Division. *SDG indicators, 2025*. https://unstats.un.org/sdgs/report/2023/goal-11/

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