

Heat-Related Health Risks and Responses of G20 Countries

A report synthesizing the evidence ahead of the South Africa G20 Side Event:
Accelerating climate resilient development through science-driven action to reduce heat vulnerability as part of the Environment and Climate Sustainability Working Group Meeting

6 October 2025

Executive Summary

Extreme heat has emerged as one of the most pressing and inequitable global health challenges of our time. The World Meteorological Organization confirmed 2024 as the hottest year in recorded history, marking the first time that global temperatures exceeded the 1.5°C threshold set by the Paris Agreement. Across G20 countries, heatwaves are becoming longer, more intense, and more frequent, compounding health, economic, and social vulnerabilities. Heat-related deaths already exceed 489,000 per year globally, with billions of workers regularly exposed to unsafe temperatures. The urgency of this crisis has been recognized through the United Nations Secretary-General's Call to Action on Extreme Heat and multiple national and multilateral initiatives to strengthen resilience.

This report synthesizes the evidence on heat-related health risks, adaptation measures, and governance responses across G20 countries ahead of the South African G20 Presidency's Environment and Climate Sustainability Working Group. It highlights both progress and persistent gaps in policy, planning, and implementation. While many G20 countries have developed Heat Action Plans (HAPs) or equivalent strategies, these remain uneven in scope, coordination, and sustainability. Vulnerable populations—such as informal settlement dwellers, outdoor

workers, and low-income communities—continue to face disproportionate risks, underscoring the need for inclusive, locally relevant, and data-driven interventions.

The analysis calls for a new phase of science-driven, multisectoral action that transcends short-term responses. Improving the science of heat-health—integrating biometeorology, physiology, climatology, and public health—can enhance the effectiveness and applicability of HAPs. Coordinated governance, legal mandates, comprehensive vulnerability assessments, and long-term resilience planning must underpin future strategies. Only through an integrated approach—linking research, policy, and community engagement—can G20 nations collectively reduce heat-related morbidity and mortality and accelerate climate-resilient development that safeguards health and equity.

This is a draft report that is being shared as part of a side event titled 'Accelerating climate resilient development through science-driven action to reduce heat vulnerability' as part of the Environment and Climate Sustainability Working Group Meeting. We welcome feedback to update and/or amend the contents of this report. Email Prof Caradee Wright: cwright@mrc.ac.za

Contents

Executive Summary	01
Introduction	03
Heat Risk Context in G20 Countries	03
Health Risks due to Excessive Heat Exposure	04
Vulnerable Populations	05
Heat Adaptation	05
Leveraging Frontier Science to Improve Adaptation Efforts	07
Components of HAPs	07
Implementation Gaps and Challenges	07
Conclusions and next steps	08



Introduction

The World Meteorological Organization (WMO) confirmed that 2024 was the warmest year in its 175-year observational record. The annual averaged global mean near-surface temperature in 2024 was $1.55^{\circ}\text{C} \pm 0.13^{\circ}\text{C}$ above the pre-industrial (1850 – 1900) baseline average and the first time that the threshold goal of 1.5°C of warming set by the Paris Agreement was exceeded.¹ Based on global mean surface temperature data, the most recent ten years rank as the ten warmest years documented.²

Extreme heat is one of many climate change-induced risks to public health in addition to productivity, critical urban infrastructure and services etc. Heatwaves are increasing in frequency, duration and intensity; annual mean temperatures are rising; and urban heat islands are compounding risks to human health. Worldwide, it is estimated that over 489 000 deaths per year result from heat-related causes³ and 2.4 billion workers are exposed to excessive heat.⁴

The United Nations Secretary-General issued an urgent Call to Action on Extreme Heat in May 2024 and the WMO and the World Health Organization (WHO) published a joint report titled Climate Change and Workplace Heat Stress to provide guidance to build resilience amongst workers.⁵ Several global, regional and localised networks and clusters of researchers, policymakers and climate adaptation practitioners which focus on extreme heat have emerged in recent years. These communities of practice have contributed to establishing a solid evidence base from which global calls can be made, and as a directive towards future research, policy and practice responses. The number of workers affected by excessive heat is alarming and occupational safety and health protections have struggled to keep up with increasing temperatures.⁶

Against this background, representatives from G20 countries will gather in October 2025 under the South African G20 Presidency's Environment and Climate Sustainability Working Group to formulate a heat-health research agenda to address the pressing issue of extreme heat.

Heat Risk Context in G20 Countries

The urgent need for accurate estimation of heat impacts is critical for driving and informing necessary policy action at the national level. Evidence for expected increase in heat-health risk across G20 countries is provided by the statistics that follow. Projected annual mean temperature increases ($^{\circ}\text{C}$) for the year 2050 for three global warming scenarios are given in Figure 1. For a global warming scenario of 2°C , annual mean temperatures are expected to increase by at least 1°C , with some countries (e.g. Canada and Russia) projected to experience increases of 3.1°C (CMCC, undated)⁷.

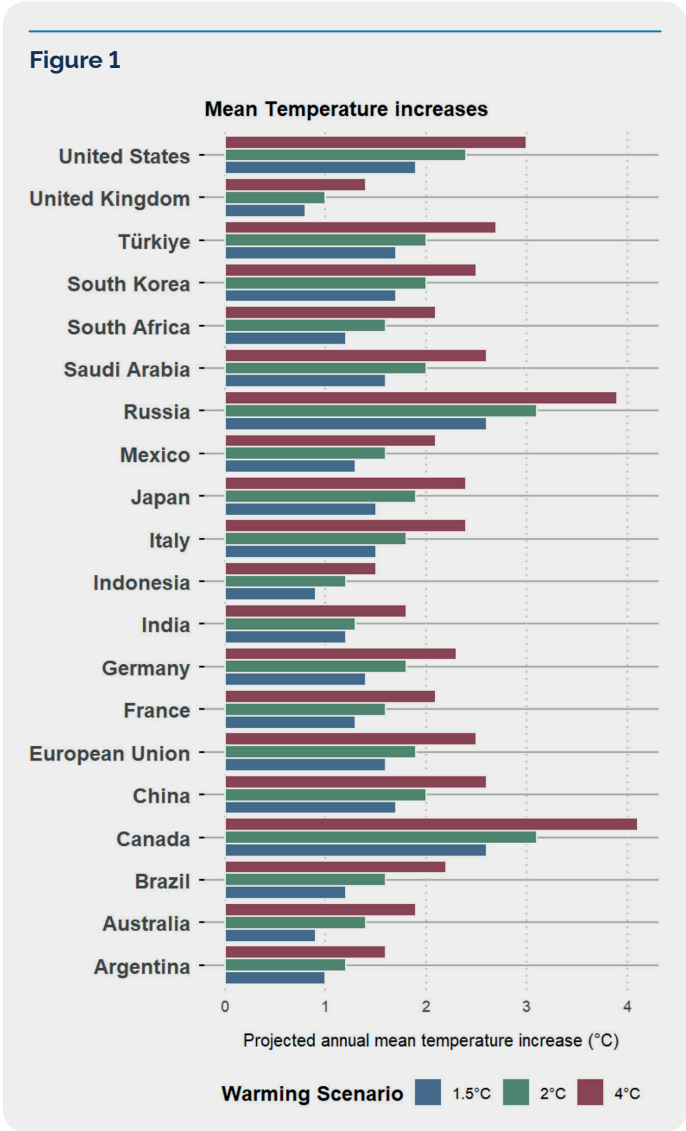


Figure 1: Projected annual mean temperature increases ($^{\circ}\text{C}$) across G20 countries for the 30-year period centred on 2050 (2036 – 2065) compared with a reference period of 1985 to 2015 for three global warming scenarios: temperature rises of 1.5°C , 2°C and 4°C ⁵.

¹ WMO, 2025. State of the Global Climate. World Meteorological Organization, WMO-No. 1368, Geneva, Switzerland. https://wmo.int/sites/default/files/2025-03/WMO-1368-2024_en.pdf.

² WMO, 2025. WMO confirms 2024 as warmest year on record, about 1.55°C above pre-industrial level [Press release]. <https://wmo.int/news/media-centre/wmo-confirms-2024-warmest-year-record-about-155degc-above-pre-industrial-level>.

³ eClinicalMedicine. The increasing burden of heat-related mortality. EClinicalMedicine. 2024 Sep 24;75:102865. doi: 10.1016/j.eclinm.2024.102865. PMID: 39763594; PMCID: PMC11701478.

⁴ ILO, 2024. Ensuring safety and health at work in a changing climate. International Labour Office, Geneva, Switzerland.

⁵ WHO and WMO, 2025. Climate Change and Workplace Heat Stress: Technical Report and Guidance, Geneva, Switzerland. <https://iris.who.int/bitstream/handle/10665/382351/9789240099814-eng.pdf?sequence=1>.

⁶ International Labour Organization (ILO). (2024). Heat at work: Implications for safety and health. <https://www.ilo.org/publications/heat-work-implications-safety-and-health>

⁷ CMCC (undated). G20 Climate Risk Atlas. Centro Euro-Mediterraneo sui Cambiamenti Climatici (SMCC), Lecce, Italy. <https://www.cmcc.it>.

Statistical projections for the same three scenarios for the median year 2050 provide evidence of marked increases in heatwave duration (Figure 2) and heatwave frequency (Figure 3). For example, for the global warming scenario of 2°C, the percent increase in duration is ten-fold exceeds 1 000% for Argentina and Brazil, and is five-fold for India, Indonesia, Mexico, Saudi Arabia, South Africa and Türkiye. Percent increase in frequency is highest for Saudi Arabia (69%) and above 50% for the same set of countries in the global South mentioned before.

Given the evidence of increased heat exposure, it is not unexpected to find increased heat-related mortality rates. In 2018, increases in heat-related deaths compared with a 2000 – 2004 baseline, ranged between 15% (Russia) and 191% (Brazil)⁵.

Figure 2

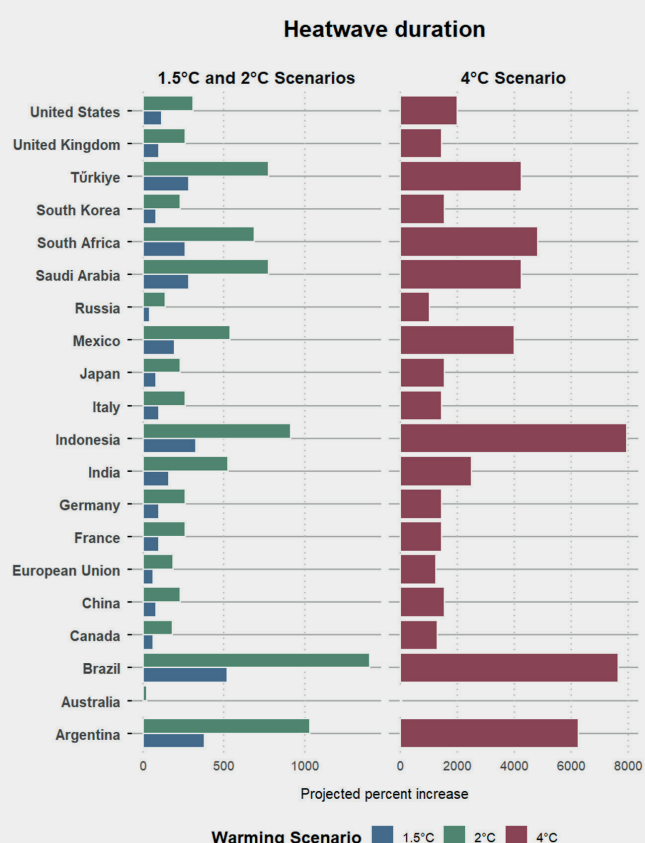


Figure 2: Projected percent increases in heatwave duration across G20 countries for the 30-year period centred on 2050 (2036 – 2065) compared with a reference period of 1985 to 2015 for three global warming scenarios: temperature rises of 1.5°C, 2°C and 4°C⁵.

Figure 3

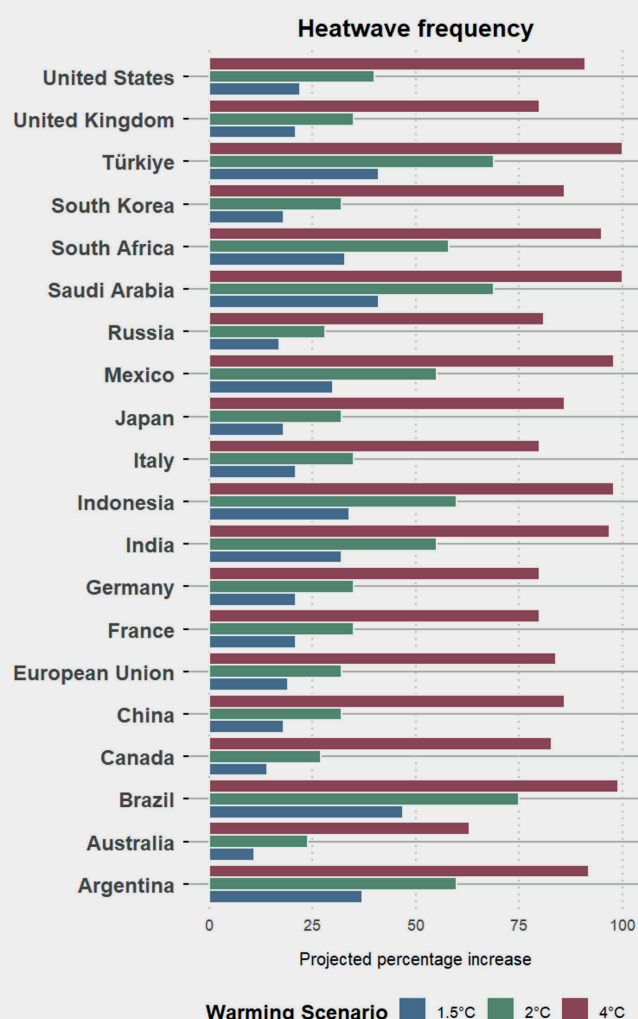


Figure 3: Projected percent increases in heatwave frequency across G20 countries for the 30-year period centred on 2050 (2036 – 2065) compared with a reference period of 1985 to 2015 for three global warming scenarios: temperature rises of 1.5°C, 2°C and 4°C.

Health Risks due to Excessive Heat Exposure

Exposure to excessive heat is a growing public health concern that includes direct and indirect health effects and exacerbation of existing health conditions.⁸ Direct effects include heat-induced fainting caused by a fall in blood pressure, heat stroke, a severe life-threatening condition that can lead to death; heat-induced brain seizures; heat exhaustion, expressed as dizziness, nausea and dehydration; and hyperthermia, a condition in which the body is unable to regulate its internal temperature causing damage to organs.⁹ Indirect effects involve

⁹ <https://www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health>

⁸ Kjellstrom T, Freyberg C, Lemke B, Otto M, Briggs D. Estimating population heat exposure and impacts on working people in conjunction with climate change. *Int J Biometeorol*. 2018 Mar;62(3):291-306. doi: 10.1007/s00484-017-1407-0.

increased risk of infectious diseases due to the expansion of the range of vector-borne diseases such as malaria and dengue carried by mosquitoes, and Lyme disease carried by ticks; increased incidence of workplace and traffic accidents and injuries due to heat-induced exhaustion; loss of productivity; negative economic consequences due to workplace heat stress; increased pressure on healthcare systems as a result of increased heat-related hospital admissions; and water shortages which lead to increased risks of waterborne diseases and dehydration.¹⁰ Many chronic illnesses such as cardiovascular, respiratory, and kidney diseases as well as diabetes are exacerbated by heat. Mental health, e.g., schizophrenia, is also affected as heat is known to increase anxiety and aggression and can cause sleep disturbances. Heat can lead to cognitive impairment and overall reduction of well-being.

Vulnerable Populations

Certain groups are especially vulnerable to excessive heat exposure and their needs should be addressed in Heat Action Plans (HAPs). Chief among the vulnerable group are the elderly as a result of less efficient thermoregulatory mechanisms and chronic health conditions; infants and young children;¹¹ pregnant women;¹² people with mental and physical challenges;¹³ indoor workers in poorly ventilated factories; outdoor workers such as agricultural and construction workers, some industrial workers and miners; athletes and urban residents who are exposed to the urban heat island. Low-income and informal communities, especially dwellers in informal settlements and with poor housing conditions, and informal economy businesses are highly vulnerable as they have limited access to resources such as potable water, cooling systems and healthcare facilities, and little regulation of building quality or occupational health. Similarly, formal, informal and emergency facilities for migrants, refugees and/or displaced people are vulnerable to the effects of excessive heat.¹⁴

Heat Adaptation

G20 countries have made good progress in adapting to and preparing for heat risks. Responses vary across the nations but are generally captured in a Heat Action Plan (HAP). While this term is widely used, alternatives include, for example, Heat-Health Action Plan (HHAP) in the UK, Heatwave Preparedness and Response Plan in Australia and parts of the US, and a National Cooling Action Plan (NCAP) in China.

Governance arrangements differ across the various countries. Some G20 countries have a single national HAP or equivalent that is centrally coordinated, whereas others have a national framework or national guidelines that address heat risks directly. HAPs at regional or local levels may exist in both cases. A few G20 countries have national HAPs that are in development and are classified as such. Other G20 countries have HAPs that are embedded within a broader national framework or strategy that addresses health, planning or climate change, and not necessarily heat directly. These countries are classified as having embedded plans. A minority have HAPs with decentralized coordination at the state or local government level, rather than a centrally coordinated plan. A couple of G20 countries, have no formal HAP but acknowledge the risks posed by extreme heat and utilise weather forecasting services to provide localised warnings for high temperatures. These various governance approaches to addressing health risks of heat are summarized in Table 1.

Table 1: Summary of governance approaches to responses to heat risks across G20 countries. Information was drawn from publicly available evidence on the Internet using Google search engine. Some documents may exist but are not publicly available therefore we may have missed some information.

¹⁰ <https://heathealth.info/heat-and-health/>

¹¹ Lakhoo DP, Brink N, Radebe L, Craig MH, Pham MD, Haghighi MM, Wise A, Solarin I, Luchters S, Maimela G, Chersich MF; Heat-Health Study Group; HIGH Horizons Study Group. A systematic review and meta-analysis of heat exposure impacts on maternal, fetal and neonatal health. *Nat Med.* 2025 Feb;31(2):684-694. doi: 10.1038/s41591-024-03395-8.

¹² Lakhani S, Ambreen S, Padhani ZA, Fahim Y, Qamar S, Meherali S, Lassi ZS. Impact of ambient heat exposure on pregnancy outcomes in low- and middle-income countries: A systematic review. *Women's Health (Lond).* 2024 Jan-Dec;20:17455057241291271. doi: 10.1177/17455057241291271.

¹³ Cianconi P, Betrò S, Janiri L. The Impact of Climate Change on Mental Health: A Systematic Descriptive Review. *Front Psychiatry.* 2020 Mar 6;11:74. doi: 10.3389/fpsy.2020.00074.

¹⁴ Romanello M, et al. The 2022 report of the Lancet Countdown on health and climate change: health at the mercy of fossil fuels. *Lancet.* 2022 Nov 5;400(10363):1619-1654. doi: 10.1016/S0140-6736(22)01540-9. Epub 2022 Oct 25. Erratum in: *Lancet.* 2022 Nov 12;400(10364):1680. doi: 10.1016/S0140-6736(22)02169-9. Erratum in: *Lancet.* 2022 Nov 19;400(10365):1766. doi: 10.1016/S0140-6736(22)02314-5. PMID: 36306815; PMCID: PMC7616806.

Country	Description	Year
AUSTRALIA	The National Heatwave Warning Framework. States have their own HAPs.	2022
FRANCE	Plan Canicule.	2017
	It provides heat alerts and co-ordinated governance at a national level. There are also regional and municipal HAPs.	
INDIA	The National Disaster Management Authority (NDMA) has issued Heat Action Guidelines, and many states and local municipalities have developed formal HAPs.	2016
INDONESIA	Has a National Cooling Action Plan (I-NCAP). While not a formal HAP, it includes strategies for cooling across many sectors. The CoCHAP (Challenge to Change: Extreme Heat in Indonesia) project is developing early warning systems at local level.	2024
ITALY	Has a Heat-Health Watch Warning System (HHWWS) implemented in major urban areas.	2003
	A National Plan for the Prevention of Heat-Related Effects on Health. Also has a National Plan for Adaptation to Climate Change (PNACC) that includes health.	2020
SOUTH AFRICA	Does not have a standalone national HAP but has Guidelines for Heat-Health Interventions. Provinces and cities have their own local heat response initiatives.	2020
TÜRKİYE	Temperature and Heat Waves Action Plan.	2010
	National Climate Change Adaptation Strategy and Action Plan includes management of heat risks. Local initiatives are developing through the ÇİSİP project.	2020
UNITED KINGDOM	Has a national Heat-Health Action System. Local authorities also implement heat action measures.	2022
UNITED STATES	The National Heat Strategy (2024 – 2030) represents a centrally coordinated initiative to address extreme heat. Actions are implemented across various agencies and at federal, state and local government levels.	2024
BRAZIL	A national HAP is under development. Cities implement local heat action measures.	NA
GERMANY	At the national level, project Nat-HAP is developing a legal framework for a national HAP. Cities have developed their own HAPs.	NA
ARGENTINA	Has a national Early Warning System for Extreme Temperatures but not a comprehensive national HAP. Climate Actions Plans that include mitigation and adaptation measures for heat exist at local levels.	2018
EUROPEAN UNION	European Union through WHO Euro issued Guidance for countries in 2008 following the 2003 extreme heatwave (which killed more than 70 000 people across the continent). They are now updating it and will publish it 1st semester 2026.	NA
CANADA	Responses to heat are embedded within its broader National Adaptation Strategy and the Government of Canada Adaptation Action Plan (GOCAAP). Federal government provides funds to support local initiatives. Provinces and cities have developed their own heat response plans.	2023
CHINA	Launched a national strategy, Climate Change Health Adaptation Action Plan (2024 – 2030), to address health impacts of climate change.	2024
JAPAN	Adopted a National Plan for Adaptation to the Impacts of Climate Change, which includes adaptation measures to heat stress emergencies. There are also municipal initiatives.	2015
MEXICO	National climate policies (e.g. National Adaptation Program and Special Climate Program) address climate risks, including heat risks. Cities implement local heat action measures.	2009
SOUTH KOREA	Has a Third National Climate Change Adaptation Plan (2021 – 2025). It aims to build resilience across various sectors, including health, and includes actions to address extreme heat. Extends to local level as well.	2020
RUSSIA	Does not have a separate, formal national HAP. Risks of climate change, including extreme heat, are acknowledged in broader climate and energy policies (e.g. National Climate Adaptation Strategy, 2019-2022). The national weather agency issues high-temperature warnings but no dedicated health response plan exists.	2019
SAUDI ARABIA	Does not have a formal national HAP. Extreme heat is recognized as a critical public health challenge. Green initiatives to plant millions of trees and early warning systems for heat waves have been implemented. Heat preparedness plans have been developed for large-scale events such as the Hajj.	NA

Leveraging Frontier Science to Improve Adaptation Efforts

Extreme heat is now recognized as one of the most urgent global health threats threatening billions of workers and communities exposed to unsafe temperatures. With recent years being the hottest on record, urgent and coordinated action is needed to protect populations and strengthen resilience. Yet, this challenge is not only about implementing HAPs — it is fundamentally about deepening our scientific understanding of how humans live, work, and adapt in a rapidly warming world. Addressing heat risks effectively requires bridging knowledge gaps and advancing research that connects the biological, environmental, and social dimensions of heat exposure and health outcomes.

To move forward, more and better science is needed across multiple disciplines — from biometeorology, physiology, and climatology to public health, social sciences, and occupational health. Each field provides essential insights into how heat interacts with human bodies, environments, and systems. Integrating these disciplines can help us better predict vulnerability, understand thresholds of human tolerance, and design targeted interventions that are both context-specific and equitable. This multidisciplinary approach not only supports evidence-based adaptation but also ensures that heat-health strategies remain responsive to changing climate realities.

Strengthening scientific understanding in this way directly enhances the effectiveness and applicability of HAPs. By grounding HAPs in locally relevant data, physiological evidence, and community-informed perspectives, they can evolve beyond emergency responses into proactive frameworks that safeguard health, livelihoods, and development. Ultimately, improving the science behind how we experience and respond to heat will allow societies to build resilience that is inclusive, sustainable, and grounded in the realities of life in a warming world.

Components of HAPs

Typically, HAPs include early warning systems where citizens receive alerts that may be colour-coded and which trigger appropriate behavioural responses.

Other common features include public health interventions related to the installation of drinking water stations, cooling centres and heat shelters, as well as medical preparedness, for example, hospital readiness.

Infrastructure and urban planning measures relate to greening initiatives, such as planting of trees, creation of green corridors, green roofs etc. Also included are adjustments to building standards to promote ventilation and provide protection from the sun.

Public awareness campaigns and education strategies such as the training of healthcare workers are important components of HAPs.

Workplace regulations are often included for affected sectors such as agriculture and construction to protect outdoor workers.

Innovative features of HAPs in G20 countries embrace a variety of low-tech interventions and digital tools to strengthen resilience against excessive heat. For example, in Ahmedabad, India, reflective roof painting in informal settlements and misting sprinklers at bus stops have been introduced. Personalized heat alert messaging through mobile telephone networks is used in South Korea. Under the G20's Disaster Risk Reduction Working Group, there is an initiative to introduce universal early warning systems, which could include heatwave alerts, by 2027.

Implementation Gaps and Challenges

While HAPs (or an equivalent) are used as vital policy tools to address excessive heat by most G20 countries, there remain significant gaps in implementation and consequently areas for improvement.¹⁵ These include:

Lack of institutional coordination: Poor coordination across various government levels and sectors hampers implementation and accountability. This includes vertical fragmentation between local and national governments and horizontal disconnects across relevant sectors such as health, planning and labour.

Lack of a legal mandate: Most G20 countries do not classify heatwaves as natural disasters. The absence of a legal mandate means that dedicated emergency funding is not released, compromising preparedness and responsiveness. A change in classification would allow access to national disaster funds rather than relying on municipal budgets and would enable coordinated emergency responses. An exception is Japan, where heatwaves are recognized as disasters, as was the case in the 2018 heatwave.

¹⁵ <https://heathealth.info/wp-content/uploads/Assessment-of-Heat-Action-Plans-3.pdf>

Insufficient localization: As a result of top-down planning, action plans are often too generic and fail to adapt to local vulnerabilities and local climate variations. Cities are often prioritized leading to the neglect of heat stress in rural areas.

Need for improved science: Quality science and evidence is critical to understand the most practical and effective ways to adapt in terms of heat exposure.

Neglect of vulnerable populations: Inadequate attention to vulnerable populations gives rise to equity gaps and emphasizes the need for inclusive planning.

Weak monitoring and evaluation systems: Inadequate collection of real-time data on heat-related illnesses or mortality impacts response times. The lack of reliable outcome assessments hampers evaluation of whether action plans are having the desired response.

Lack of long-term, structural planning: Many action plans focus on short-term, reactive solutions to heat stress and fail to embed the responses in the development of long-term resilience through adaptation measures that integrate with urban planning, building regulations or infrastructure design and technology.

Public perception and behaviour challenges: Individuals often do not perceive heat as a serious health threat, with the result that there is poor adherence to preventive advice. Heat threats are often eclipsed by more visible and dramatic disasters.

Mental health: Consideration of mental health and general well being is less prominent than that of the physical health implications of heat. This limits the integration of mental health and wellbeing responses into strategic planning and implementation measures.

Most HAPs Lack Comprehensive Vulnerability Assessments and Long-Term Resilience Strategies: Few HAPs incorporate systematic vulnerability mapping that combines demographic, physiological, occupational, and environmental risk factors. Without such assessments, interventions often overlook the complex interplay between heat exposure, poverty, gender, age, and health conditions. Long-term resilience strategies are rarely embedded, leading to repeated short-term responses rather than sustained adaptation.

Early Warning Systems Are Emphasized, Missing Proactivity in Evaluation: While early warning systems have become central to many HAPs, there is insufficient attention to how warnings translate into action and measurable outcomes. Proactive, iterative evaluation—linking warnings, responses, and health outcomes—is seldom institutionalized, limiting learning and continuous improvement in heat management systems.

Single-Sector Governance Limits Comprehensive Heat Response: Most heat responses remain confined to health or meteorological departments, with limited engagement from urban planning, labour, housing, transport, and social protection sectors. This siloed governance undermines integrated action and reduces the potential for co-benefits across development, equity, and environmental resilience.

Conclusions and next steps

Extreme heat is a defining health and development challenge of the 21st century, demanding urgent, coordinated, and science-informed responses. While G20 countries have made important strides in developing and implementing Heat Action Plans, critical gaps persist in their design, coordination, and sustainability. Addressing these gaps requires reframing HAPs not merely as emergency measures but as long-term instruments for resilience-building, equity, and social protection.

The way forward must rest on stronger interdisciplinary collaboration and locally grounded evidence. Integrating insights from biometeorology, physiology, climatology, and public health can transform fragmented interventions into cohesive systems of prevention, preparedness, and adaptive capacity. Moreover, embedding heat-health strategies within broader climate adaptation and urban development agendas will ensure that responses address structural vulnerabilities and produce co-benefits for livelihoods, wellbeing, and environmental sustainability.

As the G20 advances collective leadership on climate resilience, there is an unprecedented opportunity to position heat-health science at the core of global adaptation policy. By investing in inclusive research, coordinated governance, and proactive monitoring, G20 nations can protect populations from escalating heat risks while championing an equitable and climate-resilient future.