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TECHNICAL REPORT

# HEAT WAVES AND HUMAN HEALTH

EMERGING EVIDENCE AND EXPERIENCE TO INFORM  
RISK MANAGEMENT IN A WARMING WORLD



February 2019

This document was produced for review by the United States Agency for International Development. It was prepared by Chemonics for the Adaptation Thought Leadership and Assessments (ATLAS) Task Order No. AID-OAA-I-14-00013, under the Restoring the Environment through Prosperity, Livelihoods, and Conserving Ecosystems (REPLACE) IDIQ.

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Cover Photo: Mahesh Kumar/Associated Press, May 2015. An Indian man cools off in the heat in Hyderabad, India.

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Prepared for:

United States Agency for International Development  
Adaptation Thought Leadership and Assessments (ATLAS)

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This report is made possible by the support of the American People through the United States Agency for International Development (USAID). The contents of this report are the sole responsibility of the author or authors and do not necessarily reflect the views of USAID or the United States Government.

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# ACRONYMS

GHHIN	Global Heat Health Information Network
HEWS	heat wave early warning system
HHAP	heat-health action plan
IPCC	Intergovernmental Panel on Climate Change
NASA	National Aeronautics and Space Administration
NOAA	National Oceanographic and Atmospheric Administration
UHI	urban heat island
WASH	water, sanitation and hygiene
WHO	World Health Organization
WMO	World Meteorological Organization

# ACKNOWLEDGEMENTS

The authors would like to acknowledge the contributions of Nathaniel Matthews-Trigg, who conducted a literature review to inform this report.

At USAID/Washington, we are especially appreciative of the support, guidance and thoughtful comments given by Peter Epanchin, Matthew Jelacic, Geoffrey Blate, Alex Apostos, Colin Quinn, Vera Zlidar, Thomas Barnum and Kevin Nelson.

We would also like to thank individual members of the Climate Services for Resilient Development Partnership, including Juli Trtanj, Hunter Jones, Wassila Thiaw and Meredith Muth of NOAA, Joy Shumake-Guillemot of the WHO-WMO Joint Office for Climate and Health, and Julie Arrighi of the Red Cross, whose guidance helped shape this work.

# KEY MESSAGES

The World Health Organization defines heat waves as sustained periods of uncharacteristically high temperatures that increase morbidity and mortality. The extent and severity of health effects from a heat wave depend not only on its characteristics but also on the vulnerability of the affected populations. Around the world, the number and intensity of heat waves are on the rise. Of the warmest years on record across the globe, all were in the last three decades, and 2017 was the third warmest year in recorded history. According to both the National Oceanic and Atmospheric Administration (NOAA) and the National Aeronautics and Space Administration (NASA):

- The five warmest years have all come in the 2010s.
- The 10 warmest years have all come since 1998.
- The 20 warmest years have all come since 1995 (Climate Central 2018).

These high temperatures, combined with other conditions, such as relative humidity, give rise to heat waves that can claim the lives of thousands of people, destroy crops and damage infrastructure. In addition, heat waves can strain basic services. Rising temperatures cause demand for water and electricity for cooling to grow and hospital admissions to increase, often at rates that overwhelm hospital capacity. As climate change intensifies, more heat records will be broken every season, increasing risks to the world's population, especially the elderly, infants and young children, pregnant women, those with chronic health challenges or disabilities and those who work outside. Furthermore, much of the global workforce works outside—including, for example, farmers, agricultural laborers and construction workers. In addition, a significant portion of the global population now lives in cities, where pavement and buildings trap and gradually release absorbed thermal energy, exposing urban residents to higher temperatures.

**The direct and indirect impacts of heat waves are largely dictated by the vulnerability and exposure of the population affected.** When health systems are unprepared to cope with heat extremes, the most vulnerable can suffer devastating consequences. The impacts of extreme heat can be both direct, affecting the human body's physiological responses and functions, as well as indirect, decreasing food and water security and jeopardizing hard-fought gains not only in health, nutrition, and water, sanitation and hygiene (WASH), but also in health systems strengthening and activities more broadly.

**While heat waves may not bring about sweeping damage to natural, social and physical assets the way other climate stressors such as floods and droughts might, they are among the deadliest natural disasters.** Heat waves throughout Europe claimed some 70,000 lives in 2003 (Robine et al. 2008). India, which routinely faces warm temperatures throughout most of the year, saw a heat wave in May 2010 that caused an excess of 1,344 deaths in the city of Ahmedabad (Azhar et al. 2014). In 2015 alone, four of the top 10 natural disasters producing the most fatalities were heat waves (United Nations Office for Disaster Risk

Reduction 2016). While data for Africa and other regions of the world are limited or considered dubious by many scientists, in 2018 a heat wave with temperature records exceeding 40°C was recorded in northern Kenya, further drying already stressed catchment areas and putting pressure on the country's vulnerable livestock communities.

**Heat waves pose a range of health risks, from minor heat rashes to heat exhaustion and potentially deadly heat stroke.** They are also linked to other health problems such as respiratory and cardiovascular disease, kidney disorders and mental illness. As temperatures rise and climate variability increases, most of the world is expected to experience increased impacts from heat extremes, even while taking into account gradual acclimatization to higher temperatures—both physiological adjustment and deliberate adaptation interventions (Huang et al. 2011).

**Almost the entire world experiences—and will continue to experience—heat waves, but climate models show expanding risk in higher latitudes and even greater risk in places that already experience warm weather.** Many of these places, for example, South and Southeast Asia and West Africa, already face challenges to climate change adaptation, including relatively low adaptive capacity, rapidly growing populations, inadequate cooling infrastructure such as air conditioning or cold supply chains that preserve vaccines, essential medicines and food. In addition, our rapidly urbanizing world will become more sensitive to extreme heat due to the urban heat island effect found in cities and other built environments, the heat effect of energy absorbed and retained in surfaces such as pavement, concrete and glass. The increasing number and intensity of heat waves will require countries to ramp up preparedness and improve heat interventions.

**Efforts to better understand and manage the risks of extreme heat have emerged in the wake of recent and deadly heat waves around the world.** For example, the World Health Organization (WHO) and the World Meteorological Organization (WMO) established a Joint Office for Climate and Health, which released guidance on warning system development for heat waves in 2015. Increases in injuries, illnesses and deaths from high temperatures resulted in increased research on identifying 1) thresholds for adverse health outcomes; 2) populations particularly vulnerable to heat exposures; and 3) effective interventions to prevent adverse health outcomes. While this research has been a valuable contribution to the field of climate risk management, more needs to be done to ensure that thresholds are accompanied by appropriate interventions and response mechanisms to address and adaptively manage risks, particularly among the most vulnerable populations. Around the world, communities, cities and countries have begun pilot interventions to mitigate the impact of heat waves, but more systematic and robust assessment of these interventions is needed. Several networks and communities of practice have begun to coalesce around risk management practices for addressing extreme heat, for example, the Global Cool Cities Alliance, the C40 Cities Climate Leadership Group, the Cool Cities Network, the Climate Services for Resilient Development partnership (CSRDP) and the Global Heat Health Information Network (GHHIN). These networks and communities provide opportunities for exchanging knowledge and raising awareness that

can lead to interventions and investments that can be brought to scale in the medium and long term.

**The public health burden of heat waves in particular can be eased by building resilience into health systems** through 1) advancing preparedness by improving forecasting skill and investing in vulnerability assessments to inform risk management and communication of actionable recommendations, especially to the most vulnerable populations, for minimizing heat risks, and 2) improving heat interventions by prioritizing intersectoral collaboration and implementing responsibility and accountability mechanisms for extreme heat preparedness, response and adaptation. Many cities across the world are developing heat-health action plans (HHAPs), which include a heat wave early warning system (HEWS) and emergency public health measures.

This report provides a starting point to inform risk management in a warming world with a specific emphasis on experiences in the developing world. It is structured as follows:

- *What are heat waves?* describes the physical characteristics of extreme heat, including heat waves, and common indices used to assess and measure heat stress.
- *How do heat waves impact health?* summarizes how heat waves directly and indirectly impact mortality and morbidity, describing dimensions of heat vulnerability.
- *Heat waves under a changing climate* summarizes the likely changes to spatial and temporal aspects of heat waves under changing climatic conditions.
- *What is being done to manage heat risk?* summarizes the global experience in developing robust preparedness, response and adaptation mechanisms, including HHAPs and HEWSs.
- *Moving forward* identifies critical gaps in managing heat risk and considers actions that can enrich the global response to heat waves.