EXTREME HEAT

PREPARING FOR THE HEATWAVES OF THE FUTURE

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IFRC | OCHA | Climate Centre

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Cover photo: In a camp for conflict-displaced people in north-west Syria, children cool down in a makeshift pool in the back of a truck.

Credit: OCHA/Ali Haj Suleiman

Foreword

Climate change is already having severe impacts across our planet, bringing new and previously unimaginable challenges to the people least responsible for greenhouse gas emissions.

This report, the first we've released jointly in the history of our organizations, provides a sobering review of how just one of those challenges – the increase in deadly heatwaves – threatens to drive new emergency needs in the not-so-distant future.

The findings are startling and disturbing. Heatwaves already kill thousands of people every year, and they will become deadlier with every further increment of climate change. We hope this report serves not only as a wake-up call but also as a road map. Heatwaves demand a humanitarian response that is locally grounded, that acts quickly on the basis of data and analysis, and that works in partnerships with local governments, civil society and development actors to protect the most vulnerable people.

The challenge is daunting, but there is demonstrable success to build on, including from developing countries.

But even as we seek to improve our emergency response to extreme heat, let us be clear: This is not a problem that humanitarian organizations can solve alone. The urgent priority must be large and sustained investments that mitigate climate change and support long-term adaptation for the most vulnerable people. Without those investments, we are destined for a future of ever larger and deadlier heat disasters.

The UN Office for the Coordination of Humanitarian Affairs and the International Federation of Red Cross and Red Crescent Societies are committed to working together to avoid that future.

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  United Nations Under-Secretary-General for Humanitarian Affairs and Emergency Relief Coordinator

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Executive Summary

Extreme heat is a silent killer whose impacts are certain to grow, posing huge challenges to sustainable development and creating new emergency needs that will demand a humanitarian response.

Heatwaves account for some of the deadliest disasters on record. The European heatwave of 2003 was responsible for more than 70,000 excess deaths; the Russian heatwave of 2010 killed over 55,000 people.[1]

Impacts are not restricted to high-income countries; developing countries in Africa, Asia and Latin America have experienced severe heat-related emergencies in recent years. Indeed, almost everywhere that reliable data is available, heatwaves are the deadliest weather-related hazard. The dangers posed by extreme heat are growing at an alarming rate due to climate change.

The impacts of extreme heat are hugely unequal in both social and geographic terms. In a heatwave, the most vulnerable and marginalized people, including casual labourers, agricultural workers, and migrants, are pushed to the front lines. The elderly, children, and pregnant and breastfeeding women are at higher risk of illness and death associated with high ambient temperatures.

There is compelling evidence that the world's lowest-income countries — those least responsible for climate change — are already experiencing disproportionate increases in extreme heat. The combined effects of warming, ageing and urbanization will cause a significant increase in the number of at-risk people in developing countries in the coming decades. Projected future death rates from extreme heat are staggeringly high — comparable in magnitude by the end of the century to all cancers or all infectious diseases — and staggeringly unequal, with people in poorer countries seeing far greater levels of increase.[2]

The occurrence of extreme-heat events is unprecedented in the observed record and will grow with increasing global warming, according to the Sixth Assessment report from the Intergovernmental Panel on Climate Change. Every increment of warming matters, and the projected increases are greatest for the rarest and most extreme events.[3]

An extreme-heat event that would have occurred once in 50 years in a climate without human influence is now nearly five times as likely. Under 2°C of warming, an extreme-heat event is projected to be nearly 14 times as likely and to bring heat and humidity levels that are far more dangerous.

There are clear limits beyond which people exposed to extreme heat and humidity cannot survive. There are also likely to be levels of extreme heat beyond which societies may find it practically impossible

1. Hoah, H. "Russian Summer Tops Universal Heat Index" (2014: October) Nature. doi:10.1038/nature.2014.16250

2. Carleton T. A., et al. (2020, July). Valuing the Global Mortality Consequences of Climate Change Accounting for Adaptation Costs and Benefits. National Bureau of Economic Research. www.nber.org/papers/w27599

3. IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA. Doi:10.1017/9781009157896.

to deliver effective adaptation for all. On current trajectories, heatwaves could meet and exceed these physiological and social limits in the coming decades, including in regions such as the Sahel, and South and South-West Asia. The impacts would include large-scale suffering and loss of life, population movements and further entrenched inequality. These impacts are already emerging.

Cities are at the epicentre of vulnerability to heatwaves. Informal and off-grid settlements, which share many characteristics with camps in humanitarian settings, are at particularly high risk. Analysts project a 700 per cent global increase in the number of urban poor people living in extreme-heat conditions by the 2050s.[4] The largest increases are expected in West Africa and South-East Asia.

Extreme heat will also increasingly undermine agriculture and livestock systems, degrade natural resources, damage infrastructure and contribute to migration. The International Labour Organization projects that economic losses related to heat stress will rise from US$280 billion in 1995 to $2.4 trillion in 2030, with lower-income countries seeing the biggest losses.[5]

To prevent a future of recurrent heat disasters, aggressive steps are needed now. The single most important arena for action is in slowing and stopping climate change. Limiting global warming to 1.5°C rather than 2°C could result in up to 420 million fewer people being frequently exposed to extreme heatwaves and around 65 million fewer people being frequently exposed to 'exceptional' heatwaves.[6]

Large and targeted investments in adapting to extreme heat and protecting the most vulnerable people should also be an urgent priority. At present, efforts on these fronts are woefully insufficient to avoid massive future loss and damage from extreme heat.

Heatwaves should not be approached primarily as a humanitarian issue, but there can be no escaping the need to prepare for more and larger heat-related emergency responses in the future. There is a growing body of knowledge and good practice around early warning and response systems to heatwaves. The city of Ahmedabad, India, developed a groundbreaking heatwave action plan – the first in a developing country – that has helped it to avoid over 1,100 deaths annually. Saudi authorities responsible for the hajj and umrah (which face daunting present and future risks from extreme heat) have developed an extreme-heat strategy to help protect pilgrims from the worst impacts.

Humanitarian actors, working in partnership with local authorities and international networks, have piloted promising anticipatory approaches to heatwaves in at least 13 lower-income countries. Expanding these approaches to more low-income countries and current humanitarian contexts will be a critical challenge.

Heatwaves can be reliably forecast in most places, and early actions are effective and

4. Urban Climate Change Research Network. (2018, February). How Climate Change Could Impact the World's Greatest Cities: UCCRN Technical Report. C40 Cities. www.c40.org/wp-content/uploads/2021/08/1789_Future_We_Dont_Want_Report_1.4_hi-res_120618.original.pdf

5. Working on a Warmer Planet: The impact of heat stress on labour productivity and decent work. (2019). International Labour Organization. www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf

6. Dosio, A., Mentaschi, L., Fischer, E. M., & Wyser, K. (2018, April 25). Extreme heat waves under 1.5°C and 2°C global warming. Environmental Research Letters, 13(5). iopscience.iop.org/article/10.1088/1748-9326/aab827

relatively low cost. Nearly 5 billion people live in regions where forecasts are sufficiently reliable to support the development of heatwave action plans.[7]

Rushing international assistance to a disaster is neither desirable nor effective in responding to heatwaves. Responses should be embedded in and driven by the affected communities themselves. International humanitarian actors should aim to support, rather than substitute, local responses. To play this role, these actors need to build new partnerships with local governments and development partners, increase their engagement in urban environments, invest in preparedness and risk reduction, adapt existing programming, and expand the use of forecasting and anticipatory action.

Building a humanitarian system fit to manage the future risks of extreme heat does not require a new programmatic framework or massive new financial or logistical commitments. It requires humanitarians to deliver on their pledges to transform the sector, such as those made through the Grand Bargain and the Climate and Environment Charter.

7. de Perez, E. C., van Aalst, M., Bischiniotis, K., Mason, S., Nissan, H., Pappenberger, F., Stephens, E., Zsoter, E., & van den Hurk, B. (2018). Global predictability of temperature extremes. Environmental Research Letters, 13(5). doi.org/10.1088/1748-9326/aab94a

Mobile water-mist machines help to cool people down during a heatwave in Shanghai in July 2021.
Credit: AFP/Imaginechina

Introduction

This paper has two broad objectives. First, it aims to review the scale and nature of the humanitarian challenge posed by extreme heat, both now and under future climate change scenarios. This analysis is captured in part one: 'Five things humanitarians need to know about extreme heat.'

Second, it aims to outline the type of international humanitarian system that is best suited to respond to this challenge. This analysis is captured in part two: 'Five steps to help prepare for the heatwaves of the future.'

This paper's analysis was developed through a review of academic literature and publications by scientific, governmental, humanitarian and development organizations, and through interviews with relevant experts.

With its global perspective and limited review of particular countries or regions, this paper is intended primarily as a resource for international humanitarian organizations. This framing helps to narrow the scope, but it also presents challenges stemming from the words 'international' and 'humanitarian' that should be addressed at the outset.

This paper's recommendations are framed as being for international humanitarian organizations. However, the analysis aims to show that the most effective responses to extreme heat will be locally owned and driven, and that international engagement should focus on supporting local action. Therefore, it is hoped that local and national stakeholders also find this paper of use, both in planning their work and developing the international relationships to help enable it.

Humanitarian action should be understood as occupying one end of a continuum of adaptation to extreme heat that extends from urban planning to social protection, to sustainable cooling, to early warning and response. Each organization involved in emergency response operates across a different range of this continuum, with some engaged far upstream in long-term development and adaptation, and others focused more specifically on life-saving interventions. While this paper is focused on steps that could be taken at the 'emergency end,' it argues for a risk-management approach that relies on more collective analysis and action across the entire continuum of adaptation. Therefore, it is hoped that actors focused on development and climate adaptation also find this paper of use, and that it can help overcome conceptual and institutional barriers to this type of collective action.

PART ONE

FIVE THINGS HUMANITARIANS NEED TO KNOW ABOUT EXTREME HEAT

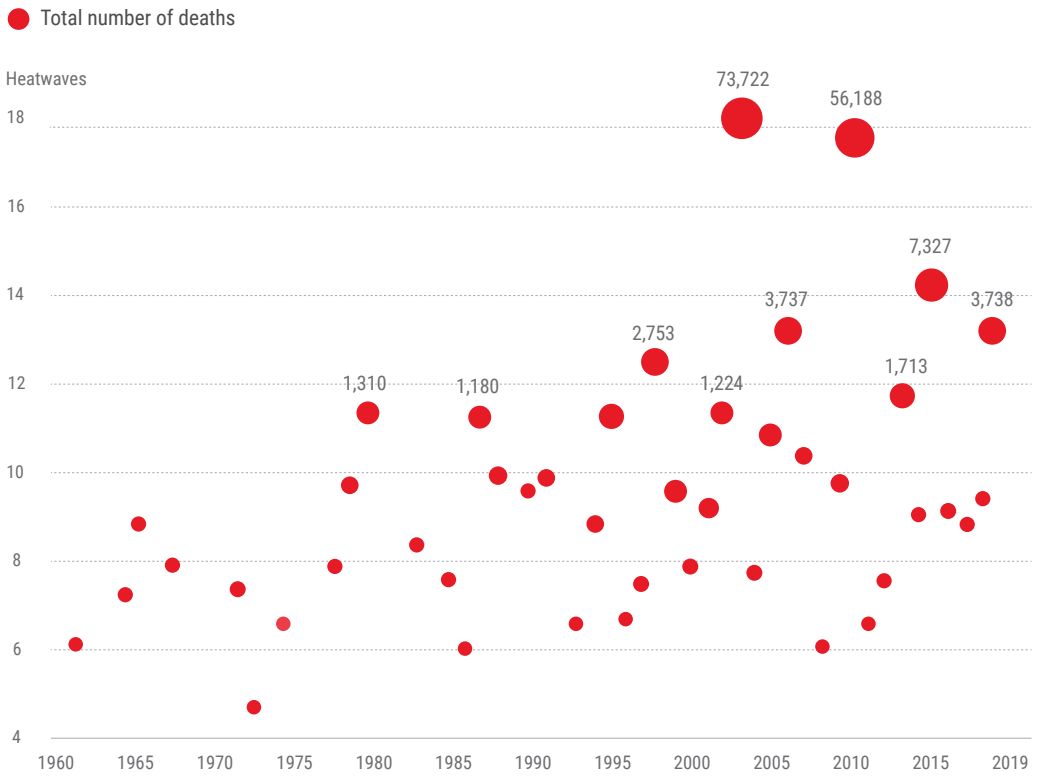
Multiple wildfires affected southern Turkey in August 2021. More than 2,000 Turkish Red Crescent staff and volunteers were on the ground supporting people in need.

Credit: Turkish Red Crescent

1. **Heatwaves are a major cause of suffering and death.**
2. **Heatwaves prey on inequality. Their greatest impacts are on vulnerable, isolated and marginalized people.**
3. **Climate change is already making heatwaves much more dangerous.**
4. **Heatwaves will become deadlier with every further increment of temperature rise associated with climate change.**
5. **Extreme heat has cascading impacts, threatening non-human life and undermining the systems that keep people healthy and alive.**

1. HEATWAVES ARE A MAJOR CAUSE OF SUFFERING AND DEATH

HEATWAVES AND DEATHS (1960–2019)



Sources: EM-DAT and Public Health England / International Federation of Red Cross and Red Cresent Societies. (2020). World Disasters Report 2020: Come Heat or High Water - Tackling the Humanitarian Impacts of the Climate Crisis Together. reliefweb.int/report/world/world-disasters-report-2020-come-heat-or-high-water-tackling-humanitarian-impacts

- Heatwave monitoring has historically been poor, particularly in certain regions such as in parts of Africa (see Harrington and Otto, 2020). Heatwave monitoring as a 'disaster' improved after the major heatwaves in Europe and the USA in 2003 (WMO, 2015). Public Health England published additional data for 2019 which has been included to address gaps in EM-DAT data.

The climate crisis is not a future concern for humanitarians. It's happening right now.

According to a review by the International Federation of Red Cross and Red Crescent Societies (IFRC),[8] extreme weather- and climate-related disasters have killed more than 410,000 people in the past 10 years. The majority of these people were in low- and lower-middle-income countries.

Humanitarian actors tend to focus on the severe storms, droughts and floods associated with a warming planet, but there is another, less dramatic and less appreciated hazard responsible for much of this suffering. Among the deadliest of disasters is a silent killer that takes a huge and increasing toll: heatwaves.

There is no universally agreed definition of 'heatwave.'[9] What constitutes a heatwave

8. World Disasters Report 2020: Come Heat or High Water - Tackling the Humanitarian Impacts of the Climate Crisis Together. International Federation of Red Cross and Red Crescent Societies. reliefweb.int/sites/reliefweb.int/files/resources/20201116_WorldDisasters_Full_compressed.pdf

9. IPCC defines heatwaves simply as 'a period of abnormally hot weather' (www.ipcc.ch/site/assets/uploads/sites/2/2019/06/SR15_AnnexI_Glossary.pdf). Other authoritative sources, including the World Health Organization and the World Meteorological Organization, use definitions that can include factors such as duration and degrees above average minimum temperature.

depends on local and contextual factors including acclimatization, demographics, built environments and cultural norms. But heatwaves can be generally understood as periods of time when unusually hot weather becomes hazardous to human health and well-being.

Between 2010 and 2019, IFRC recorded 38 heatwaves that accounted for the deaths of over 70,000 people, making them among the deadliest hazards in that period. Gaps in data mean that this is sure to be a severe underestimate.[10] And as with other disasters, those heatwaves had long-term impacts on health, livelihoods and infrastructure that are difficult to quantify but no less real.

While they are not as seared in the imagination as major earthquakes or storms, heatwaves have accounted for some of the highest-casualty disasters of recent years. The Russian heatwave in 2010, which many scientists consider to be the most severe heat-related event on record, claimed up to 55,000 lives due to a combination of extreme heat and wildfires. Mortality estimates related to the 2003 heatwave in continental Europe are over 70,000.[11]

But heatwaves are not a problem only for temperate or high-income countries. South Asia has felt severe impacts from heatwaves in recent years, with reported deaths exceeding 3,800 during an eight-day heatwave in Bangladesh in 2008, and 2,500 in India in 2015. In the summer of 2021, 11 people in Chennai died from heat exposure in a single day while queuing at the overwhelmed hospital.[12] In 1992, a prolonged heatwave combined with drought in Southern Africa affected tens of millions of people, though precise data on excess deaths is not available.[13]

Countries as diverse as Kazakhstan, Mexico, Senegal and Vietnam have had to deploy significant emergency responses to severe heatwaves. There are important variations across continents and socioeconomic contexts, but global studies show a consistent pattern of increases in overall mortality during markedly hot periods.[14] In Bangladesh, for example, mortality has increased by as much as 20 per cent on heatwave days.[15]

The deadliest heatwaves in tropical and sub-tropical countries (particularly in Africa) can happen year-round, while in the mid to high latitudes they are usually restricted to the summer months.[16]

Heatwaves are a global threat that will form an important part of the humanitarian landscape in the twenty-first century. How big a part depends not only on climate change but also on how Governments and their national and international partners work together to anticipate, prepare and respond.

10. Ben Clarke et al (2022). Extreme weather impacts of climate change: an attribution perspective. Environ. Research: Climate 1 012001

11. J.M. Robine et al., C. R. Biologies 331 (2008). Death toll exceeded 70,000 in Europe during the summer of 2003. Comptes Rendus Biologies, 331(2). doi.org/10.1016/j.crvi.2007.12.001

12. de Haro, E. What if a deadly heatwave hit India? (2021, July 3). The Economist. www.economist.com/what-if/2021/07/03/what-if-a-deadly-heat-wave-hit-india

13. Harrington, L.J., Otto, F.E.L. (2020). Reconciling theory with the reality of African heatwaves. Nat. Clim. Change, 10(796–798). doi.org/10.1038/s41558-020-0851-8

14. Vicedo-Cabrera, A.M., Scovronick, N., Sera, F. et al. (2021). The burden of heat-related mortality attributable to recent human-induced climate change. Nat. Clim. Change, 11(492–500). doi.org/10.1038/s41558-021-01058-x

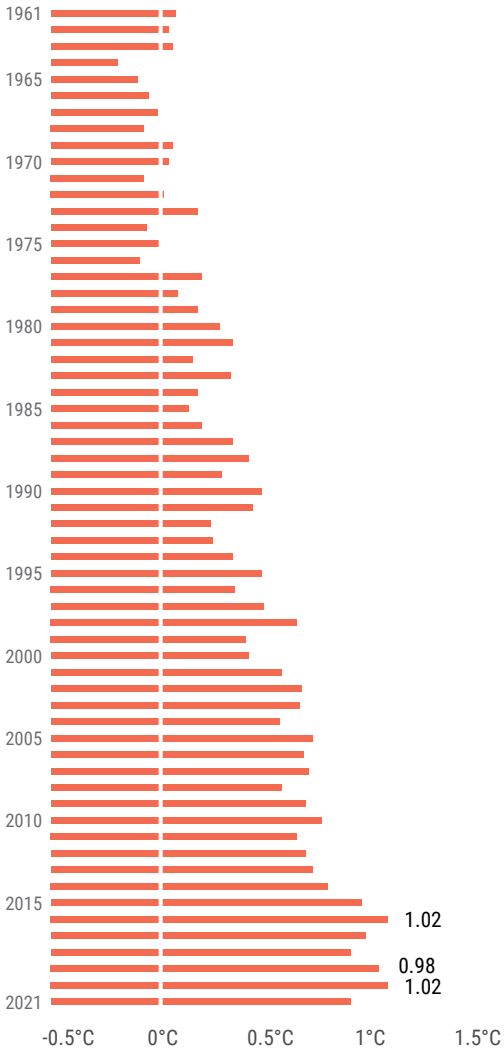
15. Nissan, H., et al. Defining and Predicting Heat Waves in Bangladesh. Journal of Applied Meteorology and Climatology, 56(10). doi.org/10.1175/JAMC-D-17-0035.1

16. See for example: Simone Russo et al (2016). When will unusual heatwaves become normal in a warming Africa? Environ. Res. Lett. 11 054016

Same Hazard, Different Challenges

It can be useful to think of rising temperatures as creating two distinct, interrelated sets of challenges for development and humanitarian action.

GLOBAL MEAN TEMPERATURE CHANGE BY YEAR (1961–2021)



Sources: Food and Agriculture Organization of the United Nations, 2021, The impact of disasters and crises on agriculture and food security, www.fao.org/3/cb3673en/cb3673en.pdf. Reproduced with permission.

Data based on the Global Surface Temperature Analysis of the National Aeronautics and Space Administration

Goddard Institute for Space Studies data.giss.nasa.gov/gistemp/

The first are the longer-term, chronic and society-wide challenges that emerge as temperatures creep ever higher. Longer hot seasons and higher average temperatures can upend livelihoods, create new pressures on social services, undermine food security, and challenge centuries-old ways of life and coping mechanisms. Humanitarians may think of this challenge as akin to a slow-onset disaster; it gradually increases pressure on communities and drives new and unforeseen needs. This paper will generally use the term 'extreme heat' for the hazard caused by high temperatures. For millions of people, extreme heat is now the new normal.

The second are the distinct, acute challenges that emerge when shorter and unusual periods of extreme temperatures and humidity pose life-threatening risks to people and communities, as in the examples referenced above. This paper will use the term 'heatwaves' to refer to these traumatic episodes. Heatwaves can be predicted significantly in advance, but humanitarians may liken them more to rapid-onset disasters; they strike the most vulnerable communities and can generate the need for an urgent, life-saving response.

When does a heatwave become a disaster?

Heatwaves do not need to have disastrous consequences. People have lived with the threat of extreme heat for millenniums, developing infrastructures and strategies that allowed civilizations to grow and flourish in even the hottest environments. This indigenous and intergenerational knowledge holds many of the keys to better management of heatwaves in the future.

But as with all extreme weather, disaster can ensue when a dangerous hazard reaches a community that is both exposed and vulnerable. In the case of extreme heat, the hazard is severe and increasing. Climate change has already resulted in ever more

frequent and dangerous heatwaves. These events will surely lead to more disasters in places where the right investments have not been made in building resilience, i.e. in reducing exposure and vulnerability.

Other factors can result in heatwaves becoming disasters. When a community's exposure or vulnerability to extreme heat changes abruptly, heat levels that previously were manageable can overwhelm coping capacity and drive new emergency needs. Obvious examples are when infrastructure is destroyed or when people are forced to flee their homes due to conflict. Climate hazards such as severe storms can destroy the shelter, water and health systems that make the hottest temperatures survivable. Climatological analysis shows that compound 'Tropical Storm – Heat' events (where extreme heat immediately follows a severe storm) could be more likely in the future.[17]

Abrupt changes in vulnerability can also come as a direct or an indirect consequence of public health emergencies. A survey of residents of low-income settlements in four developing countries found that pandemic-related restrictions on mobility and access to services contributed to measurable increases in heat-related illness.[18] These impacts also differed significantly across age groups and between men and women, which demonstrates the differentiated impact of extreme heat.

A final example involves the certainty of future power outages. In some of the world's hottest climates, millions of people rely on energy-intensive cooling – including but not limited to air conditioning – to keep their homes habitable. Urban planning and construction practices have proceeded on the assumption that this resource will be perpetually available. But, as occurred in Argentina in January 2022[19] and in Baghdad in 2021,[20] heatwaves often cause electrical grids to fail precisely when they are needed most. In the wrong circumstances, prolonged power outages – whether due to overload, accident or deliberate attack – could turn a heatwave into a mass-casualty event. One expert on heat risks in the United States considers this a 'not if but when' scenario.[21] The same observation could be made for other parts of the world.

As the threat of extreme heat increases, the systems that allow people to withstand that heat are fragile and built for the 'old' climate. Resilience can be an illusion, even for the wealthiest people.

How humans handle heat

Exposure to extreme heat can be much more dangerous than is commonly understood. When the human body temperature rises above the optimal 37°C, the blood thickens, the heart is forced to pump harder, and it and other organs can be seriously damaged. Once temperature gain overcomes the body's attempts to cool itself, dehydration and other relatively mild symptoms of heat exhaustion set in. If not treated, these symptoms can quickly lead to the much more serious and deadly heat stroke.

17. Matthews, T., Wilby, R.L. & Murphy, C. (2019). An emerging tropical cyclone–deadly heat compound hazard. Nat. Clim. Change, 9(602–606). doi.org/10.1038/s41558-019-0525-6

18. Cross, Oppermann et al. Extreme Heat and COVID-19: The Impact on the Urban Poor in Asia and Africa. Forthcoming Paper. The cities surveyed were Jakarta, Indonesia; Douala, Cameroon; Hyderabad, India; and Karachi, Pakistan.

19. Diamond, S. & Dolabjian, C. Heat wave: massive power outage in the AMBA left 700,000 users without service. (2022, January 11). La Nacion. lanacion.com.ar/economia/ola-de-calor-masivo-corte-de-luz-en-la-zona-norte-del-amba-hay-al-menos-700000-usuarios-sin-el-nid11012022/

20. Kullab, S. (2021, July 2). Power outages hit Iraq amid scorching temperatures. PBS. www.pbs.org/newshour/world/power-outages-hit-iraq-amid-scorching-temperatures

21. Sailor D. J., Baniassadi, A., O'Lenick, C. R., & Wilhelmi, O. V. (2019, May 1). The growing threat of heat disasters. Environmental Research Letters, 14(5). doi.org/10.1088/1748-9326/ab0bb9

Infants, the elderly, pregnant and breastfeeding women, people who are obese and those suffering from chronic conditions are at much higher risk of serious complications, including vital organ damage and death.[22] The exacerbation of these conditions – not heat stroke itself – is the main cause of death during a heatwave.

High maximum temperatures are not the only threat to health during a heatwave. Other factors include:

- **Duration**. Longer heatwaves lead to greater hospitalization and death.
- **Increase in minimum temperature.** When heatwaves combine extreme daytime temperatures with warmer-than-usual nights, they deprive the body of its natural recovery period and health impacts spike. This dimension is critical to future risk, as the Intergovernmental Panel on Climate Change (IPCC) found that minimum temperatures have increased by three times the mean rate of global warming, especially in higher latitudes.
- **Air pollution.** When combined with extreme temperatures, elevated levels of airborne particulate matter (including those generated by wildfire, which itself is closely correlated to extreme heat) can seriously compound health impacts, particularly in the cardiovascular system.[23]
- **Humidity.** The combination of high temperatures with high humidity dramatically lowers the cooling efficiency of sweat, making it difficult or impossible for the body to prevent overheating. For this reason, scientists use indices that express the combined effect of heat and humidity as a way to measure the danger to health posed by humid heat. In building early warning systems for heatwaves, it is critical to choose indices that reflect the full range of these risks and are appropriate to the local climate and demographics.
- **Water scarcity.** Heatwaves are associated with increased water scarcity and water stress, compounding their impact on health and depriving affected communities of a critical cooling resource.

Nobody is safe

It is a common perception that people who live in hot climates are accustomed to high temperatures and are therefore immune to the most serious impacts of extreme heat. While this is true to some extent, it would be a serious mistake to conclude that certain communities do not need to worry about heatwaves due to acclimatization.

Research shows that acclimatization varies significantly between individuals and is subject to absolute physiological limits. Acclimatization also takes time to develop, and it wanes in the absence of prolonged heat exposure. This means that it affords less protection against the types of abrupt and unusual changes in temperature and humidity that are made much more likely by climate change.[24]

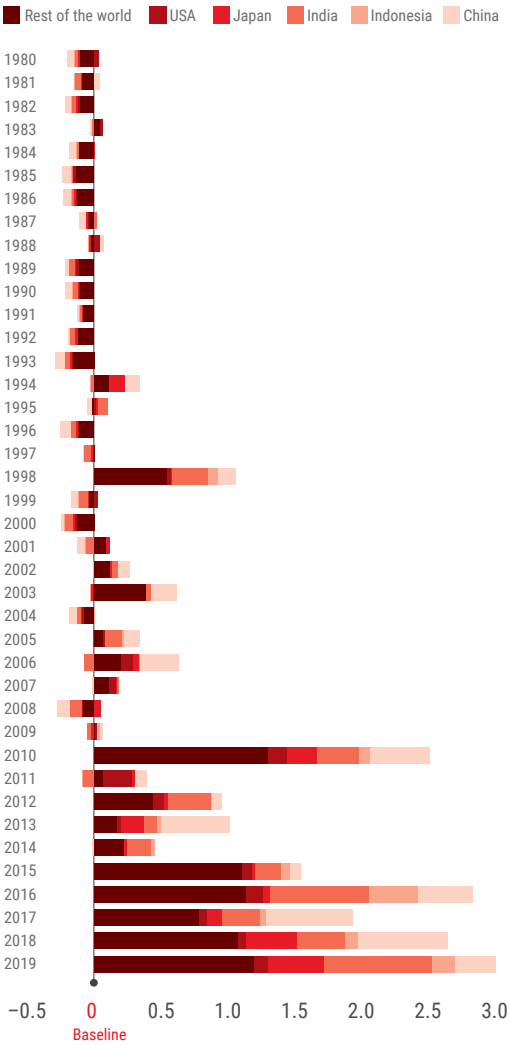
This is demonstrated by the significant mortality caused by heatwaves in typically hot climates, for example in Australia, India, Pakistan and Spain. As climate change brings new risks that lie outside the range of human experience, these extremes will test and exceed the limits of human acclimatization and systems adaptations in the hottest climates.

22. Mayo Foundation for Medical Education and Research. (2021, July 1). Heatstroke. Mayo Clinic. www.mayoclinic.org/diseases-conditions/heat-stroke/symptoms-causes/syc-20353581. See also: www.who.int/news-room/fact-sheets/detail/climate-change-heat-and-health

23. Anenberg, S.C., Haines, S., Wang, E. et al. Synergistic health effects of air pollution, temperature, and pollen exposure: A systematic review of epidemiological evidence. Environ Health 19, 130 (2020). doi.org/10.1186/s12940-020-00681-z

24. Hanna E. G. & Tait P. W. (2015, July 15). Limitations to Thermoregulation and Acclimatization Challenge Human Adaptation to Global Warming. Int. J. Environ. Res. Public Health, 12(7). doi.org/10.3390/ijerph120708034

CHANGE IN DAYS OF HEATWAVE EXPOSURE RELATIVE TO THE 1986–2005 BASELINE IN PEOPLE OLDER THAN 65



Source: Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., et al. (2020). The 2020 report of The Lancet Countdown on health and climate change: responding to converging crises. The Lancet, 397(10269), 129-170. doi.org/10.1016/S0140-6736(20)32290-X

Beware of deceiving data

The available data on the human impact of heatwaves are ominous, but they tell only a small part of the story. Relatively few countries keep comprehensive records of heatwaves and the excess mortality they cause. During periods of extreme heat, hospital admissions and fatalities from chronic conditions, such as diabetes and heart disease, uniformly rise. However, it is often the immediate cause that is recorded as the reason for hospitalization or death; the critical role of heat goes unrecorded. This reporting bias tends to mask the true impact of extreme heat.

Reporting biases can also lead to a distorted picture of the impacts of extreme heat in different parts of the world. Although there are some important exceptions, lower-income countries tend to have less-developed climate observation and weaker data collection due to poorly resourced health systems. For example, natural disaster databases tend to record little to no significant heatwave impacts in sub-Saharan Africa, despite anecdotal records and climate models showing the region as a hotspot of historic and present-day heatwaves.[25]

Addressing the data gap will be a critical step towards better understanding and responding to the impact of future heatwaves.

25. Harrington, L.J., Otto, F.E.L. (2020). Reconciling theory with the reality of African heatwaves. Nat. Clim. Change, 10(796–798). doi.org/10.1038/s41558-020-0851-8

People walk home near Behara, a town in Madagascar severely affected by drought.
Credit: OCHA/ Viviane Rakotoarivony

2. HEATWAVES PREY ON INEQUALITY. THEIR GREATEST IMPACTS ARE ON VULNERABLE, ISOLATED AND MARGINALIZED PEOPLE

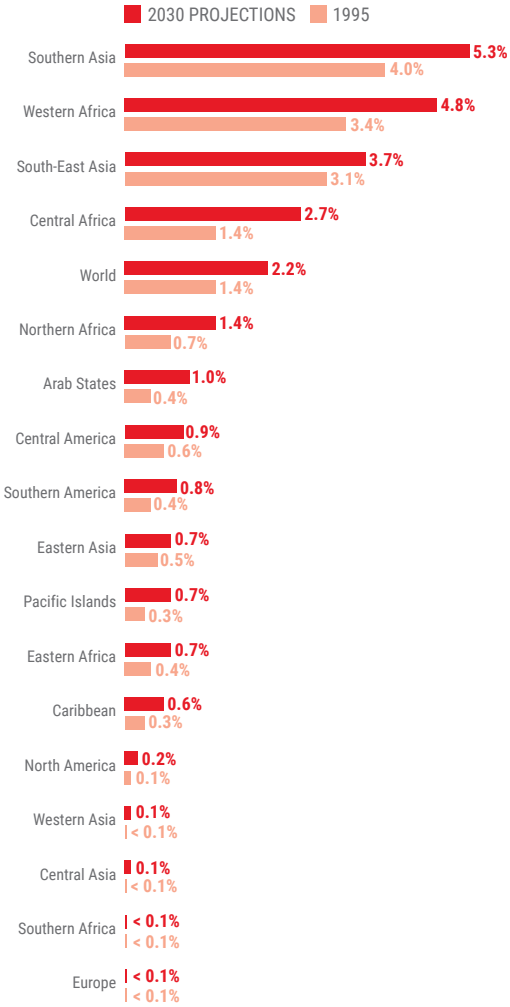
We need to talk about thermal inequality

Thermal inequality is a global problem. It is axiomatic that the most severe impacts of climate change fall disproportionately on people who bear the least responsibility for greenhouse gas emissions.

The world's lowest-income countries are already experiencing outsized increases in the occurrence of hot days and warm nights. This trend has been apparent for at least three decades and is accelerating. One study found that if the rate of change in temperature extremes remains constant, the number of hot days experienced each year in low-income countries could triple within two decades, compared to the 1961–1990 average.[26] Another study found that between 1.5°C and 2°C of global warming, the most perceptible changes in temperature will generally occur within the tropical regions – home to a disproportionate number of people living in poverty

26. Herold N., Alexander L., Green D., & Donat, M. (2017, March 1). Greater increases in temperature extremes in low versus high income countries. Int. J. Environ. Res. Public Health, 12(3). iopscience.iop.org/1748-9326/12/3/034007

WORKING HOURS LOST TO HEAT STRESS (BY SUBREGION)



Source: International Labour Organization (2019). Working on a warmer planet: The impact of heat stress on labour productivity and decent work. ILO estimates based on data from the ILOSTAT database and from the HadGEM2 and GFDL-ESM2M climate models (using as input the RCP2.6 climate change pathway, which envisages a global average temperature rise of 1.5°C by the end of the century).

www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf

and those who currently need humanitarian assistance.[27]

But thermal inequality can also be measured in acutely local and even personal terms. At the level of individual human health, there is rich medical and academic literature demonstrating the vulnerability profile associated with extreme heat. Where people in more vulnerable groups lack the means to reduce their exposure, they face greater risk. These groups include the elderly, people who are obese, people with disabilities or pre-existing medical conditions, infants, and pregnant and breastfeeding women.

Older children can also face particularly high risks during heatwaves. Children's bodies adjust more slowly to changes in environmental temperature, and they are less able to adjust their behaviours or change their environment.[28] Heat-related dehydration in children, especially when compounded by other health factors such as diarrhoea, can lead to severe illness and death. Extreme temperatures in schools can make learning impossible – many schools in India have reduced teaching hours.[29] The United Nations Children's Fund (UNICEF) estimates that 820 million children are currently highly exposed to heatwaves.[30]

Heat risks are a function of age but also of economics and culture. They are borne overwhelmingly by people with the fewest options to avoid exposure and the fewest resources to manage it. Marginalized communities are typically among those with the lowest awareness of heat-related risks. While this dimension of risk is highly

27. Herold N., Alexander L., Green D., & Donat, M. (2018, May 28). The Inequality of Climate Change From 1.5 to 2°C of Global Warming. Geophysical Research Letters, 45(10). doi.org/10.1029/2018GL078430. See also: Hideo Shiogama et al (2019) Limiting global warming to 1.5°C will lower increases in inequalities of four hazard indicators of climate change, Environ. Res. Lett. 14 124022.

28. Bernstein, A. S., et al. (2022, January 19). Warm Season and Emergency Department Visits to U.S. Children's Hospitals. Environmental Health Perspectives, 130(1). doi.org/10.1289/EHP8083

29. Kagawa, F. (2022, January). The Heat is On! Towards a Climate Resilient Education System in India. Kathmandu: UNICEF Regional Office for South Asia. www.unicef.org/rosa/media/17581/file/The%20Heat%20is%20On%20-%20India.pdf

30. The Climate Crisis is a Child Rights Crisis: Introducing the Children's Climate Risk Index. (2021, August). New York: United Nations Children's Fund. unicef.org/media/105376/file/UNICEF-climate-crisis-child-rights-crisis.pdf

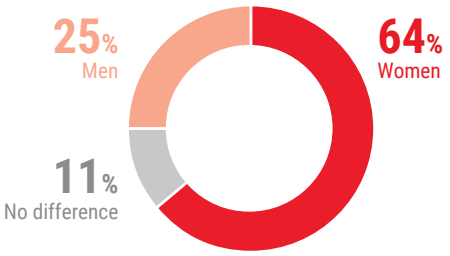
contextual, those who suffer the most in heatwaves generally include:[31]

- People who perform physical labour outdoors, e.g. construction and agricultural workers, casual labourers, traffic police, market vendors and rickshaw drivers. Outdoor workers tend to have high exposure to heat but low access to options such as breaks and cooling, or the capacity to skip days or adjust working hours.
- People with limited mobility and less access to outdoor cooling options, e.g. domestic workers, people with disabilities and elderly people living alone.
- Industrial workers. Factories and workshops can reach extremely high temperatures during heatwaves, and work can become more dangerous as heat-related fatigue sets in.[32]
- Refugees, migrants and internally displaced people (IDPs). They can face weather conditions to which they are neither physiologically nor culturally accustomed, they are disconnected from their support systems and strategies, and they can struggle to access local-language weather and public health information critical for safety during a heatwave.
- Indigenous people and extremely remote communities (who often rely on nature-based livelihoods). They may face greater exposure and often have access to fewer institutional support mechanisms.

How gender relates to risk

To understand the full profile of risk, it is critical to understand the relationship between gender and extreme heat. One example is in gendered roles in occupations with particularly high exposure to extreme heat. Men comprise around 80 per cent of global employment in the construction sector.[33] In agriculture, while there is considerable variation across regions, the global labour burden of rural women likely exceeds that of men.[34]

EXTREME WEATHER EFFECT ON WOMEN



Pie chart displaying the findings of 53 studies examining the rate of death and injury from extreme weather events: 32 found women were more likely than men to suffer death or injury from extreme weather, 12 concluded that men were more likely than women and six found no gender difference. Rounding errors mean the proportions may not add up to exactly 100 per cent.

Source: Mapped: How climate change disproportionately affects women's health. D. Dunne, 29 October 2020.

www.carbonbrief.org/mapped-how-climate-change-disproportionately-affects-womens-health/

Data source: Global Gender and Climate Alliance (2016). Additional analysis by Carbon Brief.

wedo.org/wp-content/uploads/2016/11/GGCA-RP-FINAL.pdf

31. For a useful review of socioeconomic vulnerability factors, see McGregor, G. R., Bessemoulin, P., Ebi, K., & Menne, B. (Eds.). (2015). Heatwaves and health guidance on warning-system development. WMO and WHO.
32. Working on a Warmer Planet: The impact of heat stress on labour productivity and decent work. (2019). International Labour Organization. www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf
33. World Employment Social Outlook. (2018). International Labour Organization. www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_615594.pdf
34. The Role of Women in Agriculture (2011). Rome: Food and Agriculture Organization of the United Nations. www.fao.org/3/am307e/am307e00.pdf

Heatwaves can also directly exacerbate gender inequities; evidence points to increased rates of intimate partner violence during heatwaves.[35] In addition to women being more vulnerable to heat stroke and dehydration when pregnant or breastfeeding, social and cultural factors can mean they face different and sometimes greater exposure to heat risks. In sub-Saharan Africa, extreme heat dries water sources, affects food production and thus increases women's workloads, implying they must walk long distances in the sweltering sun to find water and food.

Work such as caring for infants or the elderly tends to be less adaptable to dangerously hot conditions. In most cases, this type of work is not amenable to breaks or adjustments in working hours. For instance, in informal settlements, where structures are built with low-quality materials, more time indoors can mean prolonged exposure to temperatures significantly higher than those outdoors. The heat's intensity is amplified by limited access to outdoor greenspace, water and other cooling options. And social and cultural expectations, such as heavy layering of clothes, predispose many women and children to other direct heat-related risks.

In densely populated environments, including camps in humanitarian settings, women may face trade-offs between coping mechanisms such as bathing or opening doors and windows for ventilation, and privacy and safety concerns.[36] They can also have less access to cooling strategies that require mobility or bring protection risks, such as sleeping outdoors or on rooftops. Issues related to safety to urinate and defecate can impact hydration and eating behaviours, increasing vulnerability to heat stress.[37]

Significantly greater research is needed to better understand and respond to the gendered differences in the impact of extreme heat, including in humanitarian settings.

Mapping the inequities

The differentiated impact of extreme heat is evident in analyses of past heatwaves and in the efforts of humanitarian actors and other specialists to map extreme-heat risk.

For example, in the summer of 2015, a week-long heatwave in Karachi, Pakistan, during Ramadan caused an estimated 1,200 deaths. Most of the casualties reported were among fasting men over age 50, followed by construction workers. Most victims were people living in poverty who had little access to cooling options or flexibility to adjust their livelihood activities. Compounding factors included non-ventilated housing, prolonged power outages and discontinued water supplies. Hardly any casualties were recorded in the highest-income areas.[38]

The inequitable impact of heatwaves is also due to exposure. Significantly higher temperatures are consistently found in densely populated, poorer neighbourhoods. When the Red Cross/Red Crescent and local partners superimposed socioeconomic maps of Dhaka with temperature readings, they found that the most densely populated slum areas were experiencing the highest temperatures.[39] Studies have yielded similar results in cities as diverse as Cape Town, Hanoi, Mexico and Nairobi.

35. Sanz-Barbero, B., et al. (2018, December 10). Heat wave and the risk of intimate partner violence. Science of The Total Environment, 644(412-419). doi.org/10.1016/j.scitotenv.2018.06.368

36. For an interesting discussion of this topic see: www.coolinfrastructures.com/news-events/yi2wo40e0bgrs4on0hsgb00ymg7726

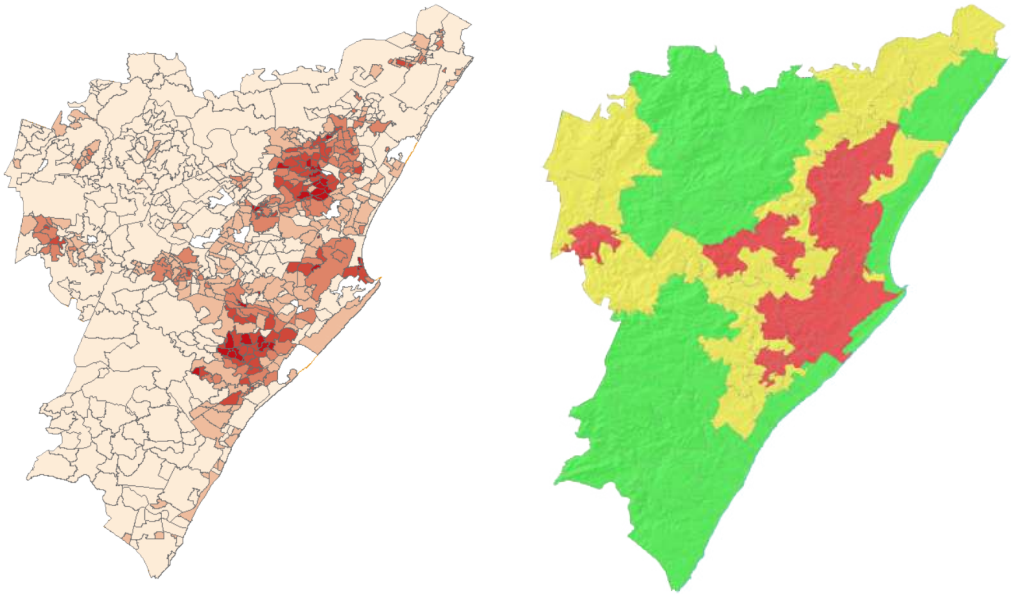
37. See for example: www.globalcitizen.org/de/content/indian-women-avoid-drinking-water/

38. Hanif, U. (2021, January). Socio-Economic Impacts of Heat Wave in Sindh. Pakistan Journal of Meteorology 13(26). www.pmd.gov.pk/rnd/rndweb/rnd_new/journal/vol13_issue26_files/7_Socio_Economic_Impacts_of_Heat_Wave_in_Sindh.pdf

39. Bangladesh Red Crescent Society. (2020). Feasibility Study on Heatwave in Dhaka. Bangladesh Red Crescent Society. www.anticipation-hub.org/Documents/Feasibility_Study/Feasibility_Study_on_Heatwave_in_Dhaka.pdf

HEAT VULNERABILITY MAPPING IN DURBAN, SOUTH AFRICA

CORRELATION BETWEEN HEAT STRESS AND SOCIAL VULNERABILITY



Social Vulnerability Index
by population density

- Very low (0 - 0.038477839)
- Low (0.038477840 - 0.096361432)
- Medium (0.096361433 - 0.176786278)
- High (0.176786279 - 0.290203754)
- Very high (0.290203755 - 1)
- eThekwini Metropolitan Municipality

Urban Heat Island Intensity

- High (>2°C)
- Moderate (1-2°C)
- Low (<0°C)

Source: Data Source: C40 Cities Climate Leadership Group. (2021). Urban Heat and Equity: Experiences from C40 Cities Network. C40 Knowledge. www.c40knowledgehub.org/s/article/How-to-adapt-your-city-to-extreme-heat?language=en_US

The relationship between inequality and exposure to heat risk is not limited to developing countries. A study of the 2003 heatwave in Paris found that excess mortality was twice as high in the most deprived areas than in the least deprived areas.[40] There is well-evidenced literature on heat risk and race in the United States.[41] For example, neighbourhoods subject to the racist practice of 'redlining' show consistently higher peak temperatures, causing greater exposure to extreme-heat risks for the most historically marginalized communities.[42] In South African cities such as Cape Town, disparities in heat exposure are a significant part of the spatial planning legacy of apartheid.[43]

40. Rey, G., Jougla, E., Fouillet, A. et al. (2009). Ecological association between a deprivation index and mortality in France over the period 1997 – 2001: variations with spatial scale, degree of urbanicity, age, gender and cause of death. BMC Public Health 9(33). doi.org/10.1186/1471-2458-9-33

41. See for example: Alana Hansen, Linda Bi, Arthur Saniotis & Monika Nitschke (2013). Vulnerability to extreme heat and climate change: is ethnicity a factor? Global Health Action, 6:1, 21364, DOI: 10.3402/gha.v6i0.21364

42. Hoffman J. S., Shandas V., & Pendleton N. (2020, January 13). The Effects of Historical Housing Policies on Resident Exposure to Intra-Urban Heat: A Study of 108 US Urban Areas. Climate 8(1). doi.org/10.3390/cli8010012

43. C40 Cities Climate Leadership Group. (2021, September). Urban Heat and Equity: Experiences from C40 Cities Network. C40 Knowledge. c40knowledgehub.org/s/article/Urban-Heat-and-Equity-Experiences-from-C40s-Cool-Cities-Network?language=en_US

Bias, bad data and inequality

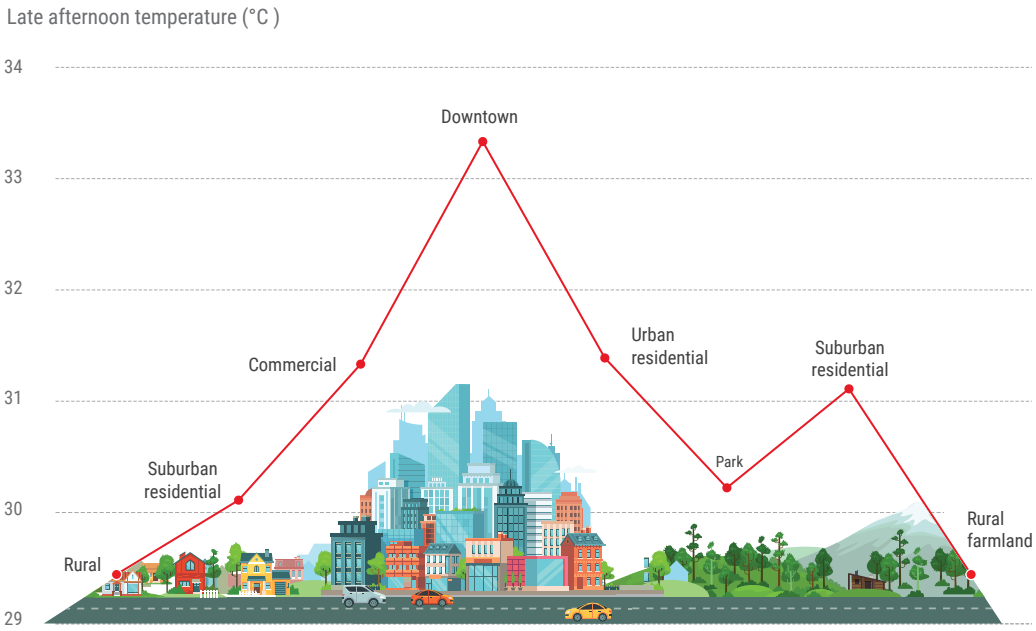
Reporting biases can also mean that the impact of extreme heat on the poorest and most marginalized people is underappreciated. People living in poverty are less likely to seek formal health care or have their cause of death recorded statistically. Weather observation stations tend to be either at airports or in relatively affluent and shaded areas. One analysis of informal settlements in Nairobi found dangerous levels of heat far exceeding those of the nearest observation station.[44] An analysis in Makassar, Indonesia, found that residents experienced dangerous heat-stress conditions inside and outside their homes that were significantly underreported by weather stations. In some cases, heat and humidity reached the upper limits of human survivability.[45]

The inequity of extreme-heat risk is projected to become ever more severe. Climate Impact Lab's comprehensive global study of heat-related mortality and income inequality found that projected future death rates from extreme heat were staggeringly high — comparable in magnitude by the end of the century to all cancers or all infectious diseases — and staggeringly unequal, with people in poorer countries seeing far greater levels of increase.[46]

Hot in the city

Nobody is immune to the dangers posed by increasing heatwaves, but the impacts are often the greatest in cities.

URBAN HEAT ISLAND PROFILE



Source: Adapted from urban heat island profile drawn by Heat Island Group, Lawrence Berkeley National Laboratory. heatisland.lbl.gov/coolscience

44. Scott A.A., Misiani H., Okoth J., Jordan A., Gohlke J., Ouma G., et al. (2017, November 6). Temperature and heat in informal settlements in Nairobi. PLOS ONE 12(11): e0187300. doi.org/10.1371/journal.pone.0187300

45. Ramsay E.E., Fleming G.M., Faber P. A., Taruc R. R., et al. (2021, November 19). Chronic heat stress in tropical urban informal settlements. iScience, 24 (11). doi.org/10.1016/j.isci.2021.103248

46. Carleton T. A., et al. (2020, July). Valuing the Global Mortality Consequences of Climate Change Accounting for Adaptation Costs and Benefits. National Bureau of Economic Research. www.nber.org/papers/w27599

Building materials such as concrete and asphalt tend to absorb and radiate heat, and heat-generating activities such as transport tend to concentrate in cities. These and other factors combine to create an 'urban heat island' resulting in daytime and nighttime temperatures significantly higher in cities than in their rural surroundings. Air pollution can also compound the health impacts of high heat and humidity in urban environments. As mean global temperatures increase, extreme temperatures in cities are increasing at a much higher rate.[47]

The patterns of exposure that come with increased and rapid urbanization also make heatwaves a serious and growing menace in cities. People living in urban poverty, particularly those in informal and off-grid settlements, face a deadly combination of exposure to higher temperatures, higher vulnerability and lower access to coping mechanisms. UNICEF estimates that 300 million children were living in urban slums in 2018, with little or no access to water and sanitation services.[48]

The IPCC determined with **high confidence** that these risks are set to escalate severely due to climate change and the projected future population growth in urban areas, particularly in middle- and low-income countries.[49] An analysis by an alliance of city governments and climate scientists projects a 700 per cent increase in the number of urban poor living in extreme-heat conditions in the coming decades. The largest increases are expected in West Africa and South-East Asia.[50] Another analysis found that by the 2090s, exposure in African cities could increase by 20–52 times (to over 200 billion person-days per year), depending on rates of climate change and urbanization.[51]

Building urban resilience to extreme heat – particularly among the poorest and most marginalized – will be a key development challenge for the twenty-first century. Success in meeting this challenge will determine how much loss and damage related to extreme heat is experienced and how prominently urban heatwaves feature in the future humanitarian landscape.

Climate challenges for camps

In emergency settings, camps and camp-like environments combine physical, demographic and socioeconomic characteristics that can make them a uniquely dangerous environment for extreme-heat impacts. They are often densely populated (particularly when settled spontaneously) and located on marginal land with limited fresh water and a lack of shading, greenspaces and other natural features that can mitigate extreme temperatures.

Most camps are in parts of the world that face high risks associated with extreme heat. In its Global to Regional Atlas, the IPCC's Working Group II analysed the current geographic distribution of camps

47. Mentaschi, L., et al. (2022, January). Global long-term mapping of surface temperature shows intensified intra-city urban heat island extremes. Global Environmental Change, 72(102441). doi.org/10.1016/j.gloenvcha.2021.102441

48. The Climate Crisis is a Child Rights Crisis: Introducing the Children's Climate Risk Index. (2021, August). New York: United Nations Children's Fund. unicef.org/media/105376/file/UNICEF-climate-crisis-child-rights-crisis.pdf

49. IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA. doi:10.1017/9781009157896.001.

50. Urban Climate Change Research Network. (2018, February). How Climate Change Could Impact the World's Greatest Cities: UCCRN Technical Report. C40 Cities. www.c40.org/wp-content/uploads/2021/08/1789_Future_We_Dont_Want_Report_1.4_hi-res_120618.original.pdf

51. Rohat G., Flacke J., Dosio A., Dao H., & van Maarseveen, M. (2019, April 4). Projections of Human Exposure to Dangerous Heat in African Cities Under Multiple Socioeconomic and Climate Scenarios. Advancing Earth and Space Science, 7(5). dx.doi.org/10.1029/2018EF001020

for refugees and IDPs against projected future increases in days of extremely high temperatures. The analysis shows a high concentration of camp settings in areas of severe projected future increases, including in sub-Saharan Africa, and West and South Asia.[52]

People in camps use coping mechanisms such as cutting down trees for fuel, which can contribute to residents' exposure to extreme heat due to loss of shade. Emergency shelters in camp environments are sometimes not in line with techniques and traditions adapted to local heat conditions, especially in unplanned sites, and camps often face significant challenges related to water and sanitation. These are exacerbated in extreme-heat conditions, with a direct impact on reproductive and maternal health.

People in camp settings can be unfamiliar with the local climate and language. This means they face risks to which they are unaccustomed, and they can have less access to the public health information that is vital to managing extreme heat. They are also disconnected from the family and informal support systems that are critical to managing periods of stress in their places of origin. Refugees, IDPs, migrants, and unaccompanied children and adolescents in camp environments have often faced trauma and suffer from health issues related to their displacement. This increases their vulnerability to the high temperatures often found in camps.

Humanitarian actors in different camp contexts are already taking steps to manage environmental risks, including rising seasonal temperatures and the risk of extreme heatwaves.

Adaptations to humanitarian programming in camps have been rolled out in some camp environments and deserve further expansion. They include establishing cool elderly care centres, using thermally appropriate shelters, and adapting service delivery and cash-for-work programmes to increasing heat stress. These steps are most effective where camps are adequately planned from the outset and benefit from proactive camp management.

Camps share many of the social and thermal characteristics of informal settlements in cities, which gives humanitarians an important opportunity to exchange and share learning with local authorities and civil society, addressing extreme heat in environments of urban poverty.

52. report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_Annex-I.pdf

Children walk beneath a sun umbrella in drought-affected Chichongole village, Guíja district, Mozambique.

Credit: IFRC/ Aurélie Marrier d'Unienville

3. CLIMATE CHANGE IS MAKING HEATWAVES MORE DANGEROUS

Unprecedented and unimaginable heat

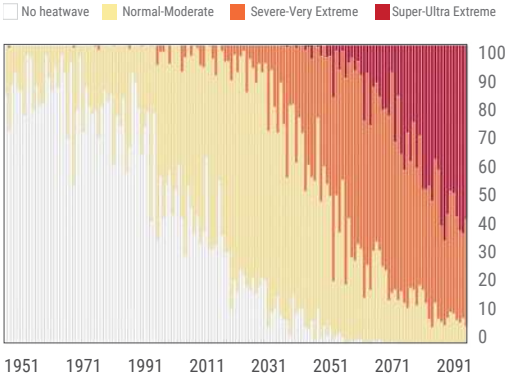
Climate change has caused an unprecedented scale of human exposure to extreme heat. Heatwaves are now more extreme, more frequent, and occurring at times of the year and in global regions that were previously unimaginable.

This increased variability is critical to understanding the present and future impact of heatwaves. They become deadlier when they exceed historical limits of severity and duration, occur outside of historically understood seasons, impact unaccustomed locations, or occur simultaneously with other extremes. All these patterns have accelerated with climate change.

The evidence supporting an increase in heatwaves in recent decades is indisputable. The IPCC found that it is **virtually certain** that hot extremes have become more frequent and more intense across most land regions since the 1950s.[53]

53. IPCC, 2021: Summary for Policymakers. In: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA. doi:10.1017/9781009157896.001.

PERCENTAGE OF LAND IN MIDDLE EAST AND NORTH AFRICA EXPOSED TO HEATWAVES



Percentage of MENA land area annually exposed to several heatwave categories for the period 1951–2100

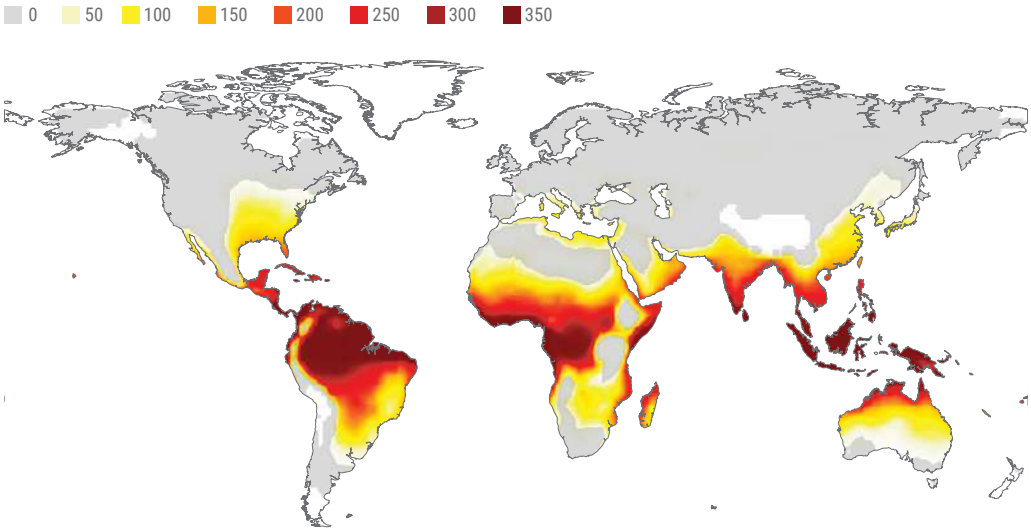
Source: Zittis, G., Hadjinicolaou, P., Almazroui, M. et al. (2021). Business-as-usual will lead to super and ultra-extreme heatwaves in the Middle East and North Africa. npj Clim Atmos Sci 4, 20. doi.org/10.1038/s41612-021-00178-7

These higher extreme temperatures – combined with the growing global trends of urbanization and ageing – have resulted in ever higher levels of risk. One study found a nearly 200 per cent increase in global urban exposure to dangerous levels of heat between 1983 and 2016, with urban warming accounting for slightly more of the increase than urban population growth.[54] The Lancet Countdown's 2021 report on health and climate change found that compared to the 1985–2005 average, young children and the elderly were together exposed to an additional 3.7 billion person-days of heatwaves in 2020.

The global trend towards ageing populations in high- and low-income contexts will also accelerate extreme-heat risks. The global population of people over age 60 stood at just over one billion in 2019, but this is projected to increase to 1.4 billion by 2030 and 2.1 billion by 2050, with the greatest increase in developing countries.[55] [56]

DEADLY HEAT LEVELS

Number of days projected to exceed potentially deadly heat levels per year by 2100



Source: Mora, C., Dousset, B., Caldwell, I. et al. Global risk of deadly heat. Nature Clim Change 7, 501–506 (2017). doi.org/10.1038/nclimate3322

54. Tuholske, C., et al. (2021, October 4). Global urban population exposure to extreme heat. Proceedings of the National Academy of Sciences, 118(41) e2024792118. doi.org/10.1073/pnas.2024792118

55. United Nations Population Fund. (2015, October 13). Ageing. United Nations. www.unfpa.org/ageing#readmore-expand

56. World Health Organization. Ageing. World Health Organization. www.who.int/health-topics/ageing#tab=tab_1

Compounded impacts, cascading problems

The impacts of heatwaves can vastly increase when they are compounded with other extreme events. Whether they occur simultaneously or in rapid succession, compound events create cascading impacts on people and communities.

One example is the risk of 'Tropical Storm – Heat' events, as noted on *page 13*. Another example is extreme heat and wildfire. Recent decades have also seen increased concurrence of extreme heat and heavy precipitation, raising the risk of compound heat-flood events.[57]

Compound events combining heat and drought should be of particular concern to humanitarian actors. The IPCC has concluded with high confidence that the frequency of concurrent heatwaves and droughts has increased globally since the 1950s. A critical example is India, where heat contributes to severe soil-moisture depletion.[58] A study of the past 60 years in India reveals a substantial increase in the frequency of concurrent meteorological droughts and heatwaves across that country. The same study reveals significant increases in areas affected by concurrent drought and heatwaves, presenting ever more communities unaccustomed to such events with an unprecedented challenge to adapt.

No one should underestimate the global impact of such compound events. Extreme heat and drought in crop-producing regions fuelled by the 1983 El Niño event resulted in what may have been the largest synchro-

HUMAN INFLUENCE ON TYPES OF EXTREME WEATHER EVENTS

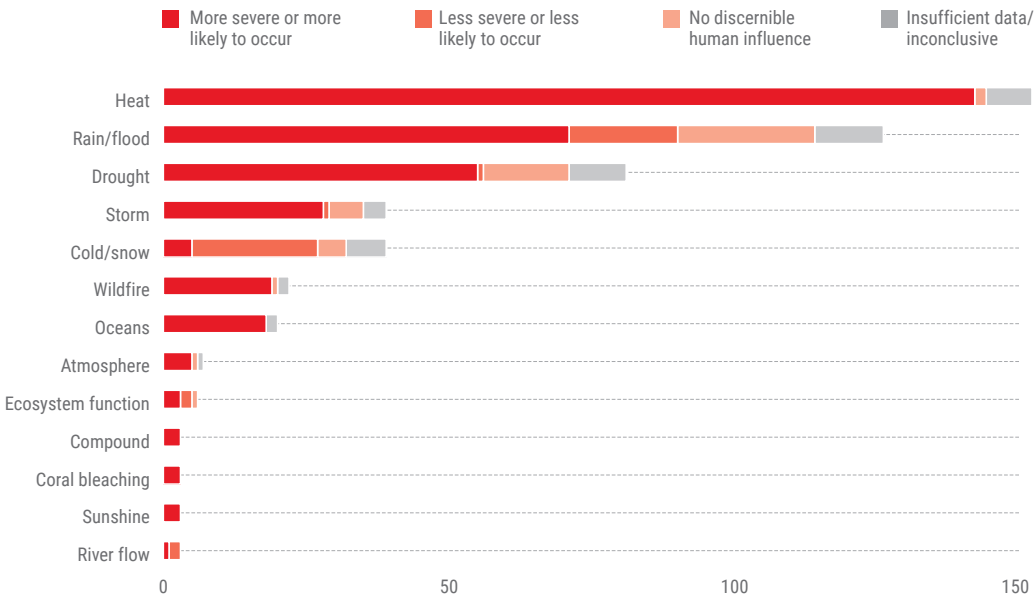
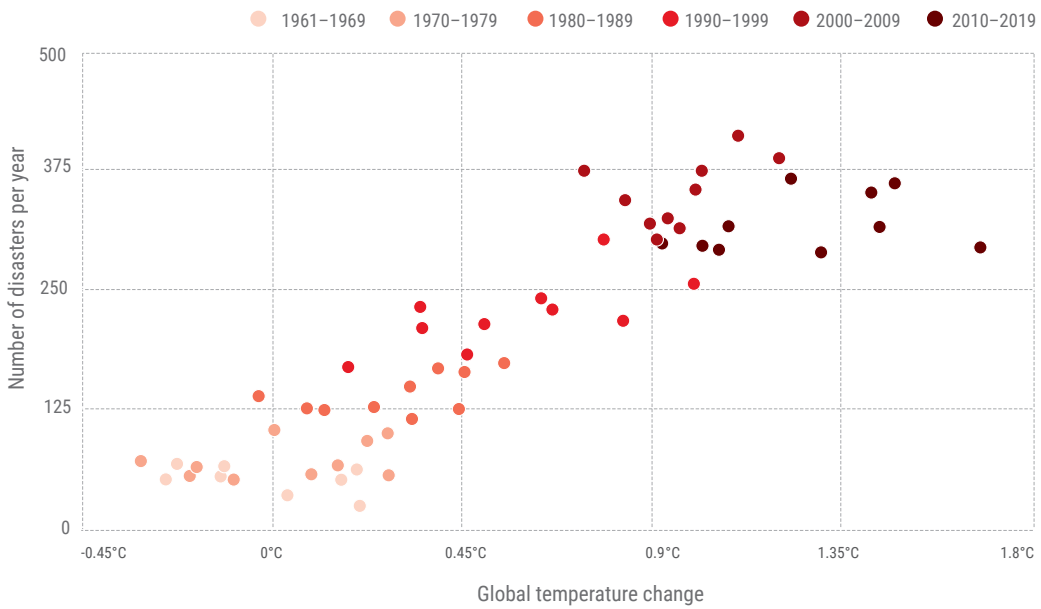


Chart shows the number of studies for each type of extreme event that fall within each category of human influence.
Source: Carbon Brief www.carbonbrief.org/mapped-how-climate-change-affects-extreme-weather-around-the-world/

57. Kornhuber, K. (2019, April 26). Extreme weather events in early summer 2018 connected by a recurrent hemispheric wave-7 pattern. Environmental Research Letters, 14(5). iopscience.iop.org/article/10.1088/1748-9326/ab13bf

58. Sharma, S. & Mujumdar, P. (2017, November 14). Increasing frequency and spatial extent of concurrent meteorological droughts and heatwaves in India. Sci Rep, 7(15582). doi.org/10.1038/s41598-017-15896-3

OBSERVED RELATION BETWEEN CLIMATE-RELATED DISASTER OCCURRENCE AND GLOBAL TEMPERATURE CHANGE



Source: FAOSTAT and EM-DAT

Food and Agriculture Organization of the United Nations (2021). The impact of disasters and crises on agriculture and Food Security: 2021. Policy Support and Governance Gateway. Food and Agriculture Organization of the United Nations. Retrieved 12 March 2022 from www.fao.org/3/cb3673en/cb3673en.pdf

nous wheat failure in modern history.[59] The 2010 extreme hot/dry event in Russia and other countries caused global wheat prices to increase up to 50 per cent — one factor among many in the urban unrest of the Arab Spring.[60]

Concurrent heat-drought events also have compounded impacts on human health, for example by limiting the availability of water for drinking and cooling precisely when it is needed most.

Data gaps and reporting discrepancies in relation to the compound impact of heat and drought limit our appreciation of the true impact of extreme heat. For example, compound drought-heat events in Africa are consistently recorded as droughts.[61] Investments in better data collection and analysis will help to improve our understanding of the present and future threat of overlapping heat and drought.

59. Anderson, W. B., et al. (3 July 2019). Synchronous crop failures and climate-forced production variability. Scientific Advances, 5(7). www.science.org/doi/10.1126/sciadv.aaw1976

60. Perez I. (4 March 2013). Climate Change and Rising Food Prices Heightened Arab Spring. Scientific American. www.scientificamerican.com/article/climate-change-and-rising-food-prices-heightened-arab-spring/#:~:text=Climate%20Change%20and%20Rising%20Food%20Prices%20Heightened%20Arab%20Spring,-The%20effects%20of&text=If%20the%20Arab%20Spring%20taught,instability%20and%20conflict%2C%20experts%20said.

61. Harrington, L.J., Otto, F.E.L. (2020). Reconciling theory with the reality of African heatwaves. Nat. Clim. Change, 10(796–798).doi.org/10.1038/s41558-020-0851-8

Attributing extreme heat to climate change

The growing field of 'attribution science' seeks to identify the degree to which a particular weather event was caused by human-induced climate change as opposed to natural fluctuations.

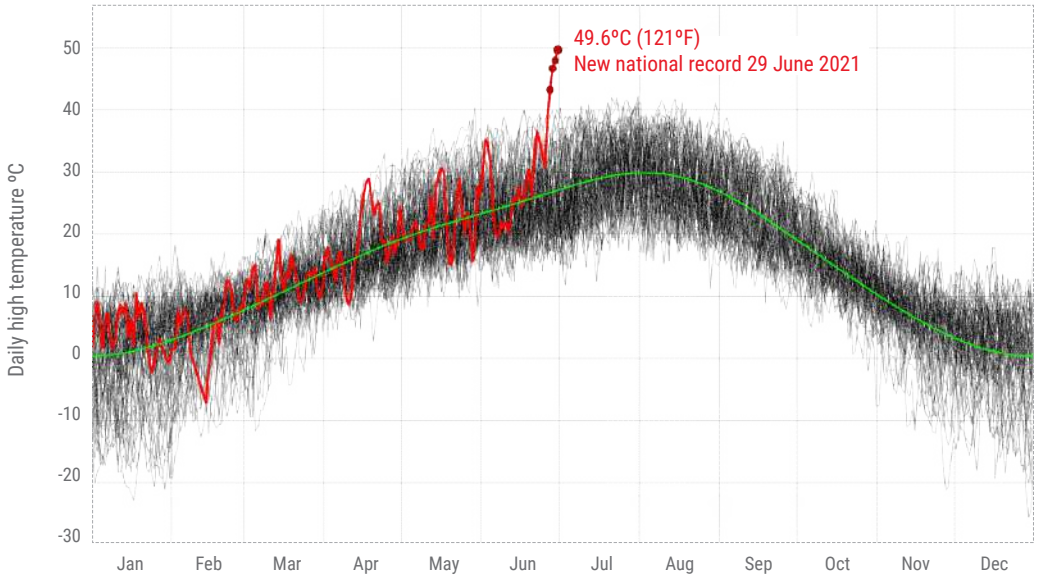
There is no hazard whose increasing severity can be attributed to climate change with greater certainty than extreme heat. The IPCC concluded that recent hot extremes observed over the past decade would have been **extremely unlikely** to occur without human influence on the climate system. And a review of more than 170 studies found that extreme heat was cited as being made more frequent or severe more than twice as often as any other event studied.[62]

An illustrative example of attribution is the infamous 'heat dome' that settled over the normally temperate Pacific North-West of the United States and Western Canada in June 2021. Rapid attribution studies found that the event would have been "virtually impossible" without human-induced climate change. The study concluded: "Looking into the future, in a world with two degrees of global warming, an event like this currently estimated to occur only once every 1000 years, would occur roughly every five to 10 years."[63]

A similar study of the extremely high temperatures in Siberia in 2020 found they were more than 600 times more likely to occur today than at the beginning of the twentieth century.[64]

DAILY HIGH TEMPERATURE

LYTTON, BRITISH COLUMBIA, CANADA (JUNE 2021)



Source: Rohde, R. (2021, July 30). June 2021 temperature update. Berkeley Earth. berkeleyearth.org/june-2021-temperature-update/

62. Schiermeier, Q. (2018, August 2). Climate as Culprit. Nature, 560(22). media.nature.com/original/magazine-assets/d41586-018-05849-9/d41586-018-05849-9.pdf

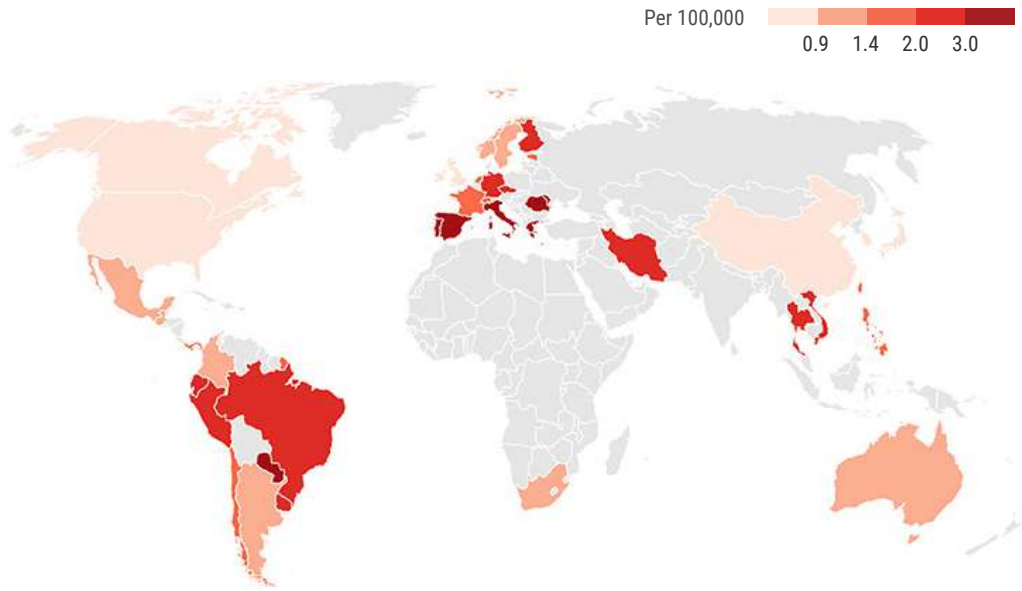
63. Sjoukje, P.Y. (2021, Nov 12). Rapid attribution analysis of the extraordinary heatwave on the Pacific Coast of the US and Canada June 2021. European Geosciences Union Discuss. doi.org/10.5194/esd-2021-90

64. Ciavarella, A. (2020, July 15). Siberian heatwave of 2020 almost impossible without climate change. World Weather Attribution. www.worldweatherattribution.org/siberian-heatwave-of-2020-almost-impossible-without-climate-change/

Scientists are moving beyond attributing particular events to human influence; they have begun to quantify the human contribution to particular impacts on people and communities. A 2021 study used the largest database ever assembled on weather and health to assess the human contribution to heat-related deaths across 732 locations in 43 countries. It found that 37 per cent (range 20.5–76.3 per cent) of warm season heat-related deaths could be attributed to climate change. It also found that climate change was driving increases in heat-related mortality in every region of the world, with notably high impacts in Latin America, South-East Asia and the Middle East.[65] This type of attributional analysis is critical to understanding the true scale of loss and damage caused by climate change.

Extrapolating these results requires caution; attribution studies have focused on high-income countries, creating possible biases in the data that need to be understood.[66] But even with these limits in mind, the signal is clear: Human-induced climate change is already making heatwaves far more dangerous, and people are feeling the impacts.

HEAT-RELATED MORTALITY RATE ATTRIBUTABLE TO HUMAN-INDUCED CLIMATE CHANGE, 1991–2018



Source: Vicedo-Cabrera, A.M., Scovronick, N., Sera, F. et al. The burden of heat-related mortality attributable to recent human-induced climate change. Nat. Clim. Chang. 11, 492–500 (2021). doi.org/10.1038/s41558-021-01058-x (Nature Climate Change)

65. Köberle, A.C., Vandyck, T., Guivarch, C. et al. (2021). The cost of mitigation revisited. Nature Climate Change, 11(1035–1045). doi.org/10.1038/s41558-021-01203-6

66. Friederike E. L. O., et al. (2020, October 1). Challenges to Understanding Extreme Weather Changes in Lower Income Countries. Bulletin of the American Meteorological Society, 101(10). doi.org/10.1175/BAMS-D-19-0317.1

During heatwaves, many children in camps in north-west Syria are at risk of severe heat stroke and dehydration, as they spend most of their time outside their plastic tents.

Credit: OCHA/ Abdul Aziz Qitaz

4. HEATWAVES WILL BECOME DEADLIER WITH EVERY FURTHER INCREMENT OF TEMPERATURE RISE ASSOCIATED WITH CLIMATE CHANGE

A global mean temperature increase of 1.5°C may be reached as early as the 2030s. But when it comes to extreme-heat risk, this figure can be misleading; 1.5°C of mean warming does not mean that the hottest day of a heatwave will be, on average, only 1.5°C hotter.

From the humanitarian perspective, a critical point is the non-linear relationship between global increases in mean temperatures and increases in the frequency and severity of extreme events. Extreme heat is the only climate hazard where this effect is so pronounced. As mean temperatures rise, extreme-heat risks are set to rise much more quickly.

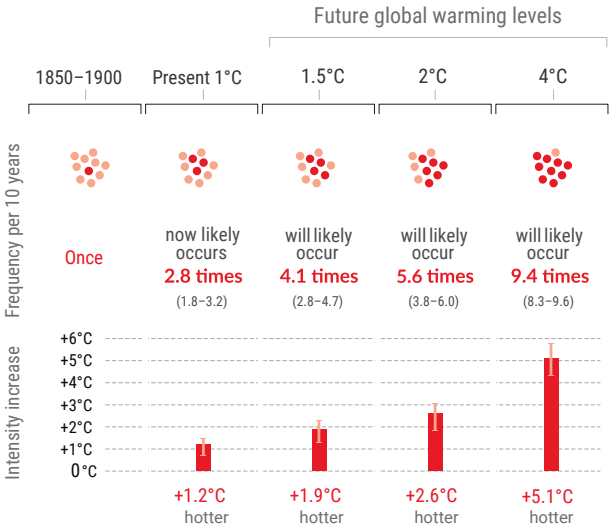
The IPCC projects that:

- **Peak temperatures in heatwaves will increase significantly faster** than global mean and local average temperatures.
- **Nighttime minimum temperatures will also increase more quickly**. Critical to the health impact of heatwaves is the decrease in nighttime cooling,

HOT TEMPERATURE EXTREMES OVER LAND

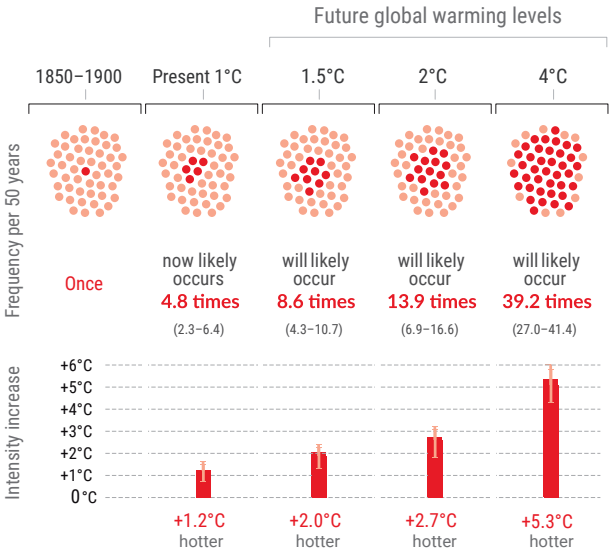
10-YEAR EVENT

Frequency and increase in intensity of extreme temperature event that occurred once in 10 years on average in a climate without human influence



50-YEAR EVENT

Frequency and increase in intensity of extreme temperature event that occurred once in 50 years on average in a climate without human influence



Source: Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. World Bank. (2020). Climate Change 2021: The Physical Science Basis - Summary for Policymakers. Intergovernmental Panel on Climate Change. www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

which gives the human body a chance to recover. One study projects a sixfold rise in concurrent daytime and nighttime heatwaves in India under 2°C warming.[67] Another study found that areas where humidity magnifies heatwaves will increase significantly with warming levels.[68]

- **Projected changes in frequency are higher for rarer events.** A range of climate hazards, including drought and heavy precipitation, will see rare events increase, but none are projected to increase as precipitously as extreme heat.

This projection of higher increases for rarer events — already borne out by recent record-shattering temperature extremes in different parts of the world — is particularly important for humanitarians to grasp, for these are the events most likely to overwhelm local coping capacities and tip communities into humanitarian need. The evidence is clear: These events will occur much more frequently as the planet warms, including in communities least prepared for them.

One way to express this increasing frequency is the 'return period' for the rarest and most severe events. An extreme-heat event

67. Mukherjee, S., Mishra, V. (2018). A sixfold rise in concurrent day and night-time heatwaves in India under 2°C warming. Sci Rep, 8(16922). doi.org/10.1038/s41598-018-35348-w

68. Russo, S., Sillmann, J. & Sterl, A. (2017). Humid heat waves at different warming levels. Sci Rep, 7(7477). doi.org/10.1038/s41598-017-07536-7

that occurred once every 50 years in the pre-industrial climate is a rare trauma. In climatological terms, it is similar to the European heatwave in 2003 that killed over 70,000 people.

The IPCC's consensus analysis of the future return period for such events is startling. At present, such a 1-in-50-year event is likely to occur 4.8 times in the same 50-year period. Under 2°C of warming it would occur nearly 14 times; under 4°C it would occur nearly 40 times, or four in every five years.

Other studies reinforce the analysis that record-breaking but also record-shattering extremes — nearly impossible without human influence — are very likely to occur in the coming decades. One study found that in high-emission scenarios, sustained and record-shattering heatwaves are between two and seven times more probable between 2021 and 2050, and three to 21 times more likely between 2051 and 2080. This means such events could occur as often as every six years in the latter period.[69]

Stark scenarios for human survival

Projected future increases in heat and humidity raise an existential question: Could extreme heat in parts of the world become so severe as to make human habitation practically impossible?

The human body's ability to shed heat reaches an absolute limit at a wet bulb temperature[70] of around 35°C. Even young, healthy people at rest lose the ability to cool themselves if exposed to heat for significant periods of time. Some coastal subtropical locations may have already reached and exceeded this level for very brief periods. One analysis suggests that at less than 2.5°C mean warming the limit could be reached regularly over land, including in the southern Persian Gulf shoreline and northern South Asia.[71]

Of particular concern from a humanitarian perspective are analyses that foresee the emergence of ultra-high impact events in regions with particularly high vulnerability. The picture is starkest under scenarios where little is done to curb carbon emissions. One study of South Asia's densely populated agricultural regions found that heat and humidity could exceed human survivability thresholds by the late twenty-first century under business-as-usual scenarios, including in Indian cities such as Lucknow and Patna.[72] Another analysis of business-as-usual scenarios predicts that in the second half of the century, super- and ultra-extreme heatwaves will emerge in the Middle East and North Africa that could bring recurring life-threatening conditions to up to 600 million people.[73] While these regions may see particularly catastrophic impacts, up to one third of the global population could experience average temperatures that until now have been found in only 0.8 per cent of Earth's land surface, mostly in the Sahara.[74]

Understanding the risk of parts of the world becoming practically uninhabitable is important, but it would be a mistake to

69. Fischer, E. M., Sippel, S. & Knutti, R. (2021). "Increasing probability of record-shattering climate extremes," Nature Climate Change, 11(8). doi.org/10.1038/s41558-021-01092-9

70. 'Wet bulb temperature' refers to the temperature as read by a moistened thermometer bulb exposed to air flow. It is a common indicator of heat stress that combines heat and humidity.

71. Raymond, C., et al. (2020, May 8). The emergence of heat and humidity too severe for human tolerance. Science Advances, 6(19). www.science.org/doi/10.1126/sciadv.aaw1838

72. Im, E., et al. (2017, August 2). Deadly heat waves projected in the densely populated agricultural regions of South Asia. Science Advances, 3(8). www.science.org/doi/10.1126/sciadv.1603322

73. Zittis, G., Hadjinicolaou, P., Almazroui, M. et al. (2021). Business-as-usual will lead to super and ultra-extreme heatwaves in the Middle East and North Africa. Climate and Atmospheric Science, 4(20). doi.org/10.1038/s41612-021-00178-7

74. Xu, C., et al. (2019, October 27). Future of the human climate niche. Proceedings of the National Academy of Sciences, 117(21). doi.org/10.1073/pnas.1910114117

make the limit of human survivability the departure point for a humanitarian analysis of extreme heat. At levels well below that limit, impacts in death and disease become severe, particularly among the most vulnerable groups. For example, the European heatwave of 2003 and the Russian heatwave of 2010, which combined are considered to have caused over 125,000 deaths, experienced wet bulb temperatures of no greater than 28°C. Equally, catastrophic damage to vital food and water systems can occur at levels well below the survivability threshold.

In certain parts of the world, extreme heat poses threats to long-term habitability that could exceed societies' capacity to provide effective adaptation for all, leading to severe loss and damage and large-scale forced displacement (see below). Equally, these threats raise the question of managed relocation (or 'retreat') of the most impacted communities, potentially including refugee or IDP camps in highly exposed areas.

The issue of retreat has been little analysed in the context of extreme heat, but it has received increasing attention in the context of broader climate adaptation,[75] and the IPCC has addressed the issue particularly in the context of rising sea levels.[76] The potential future necessity of managed retreat of the most vulnerable communities raises complex legal and ethical questions that deserve attention now, including from humanitarians.

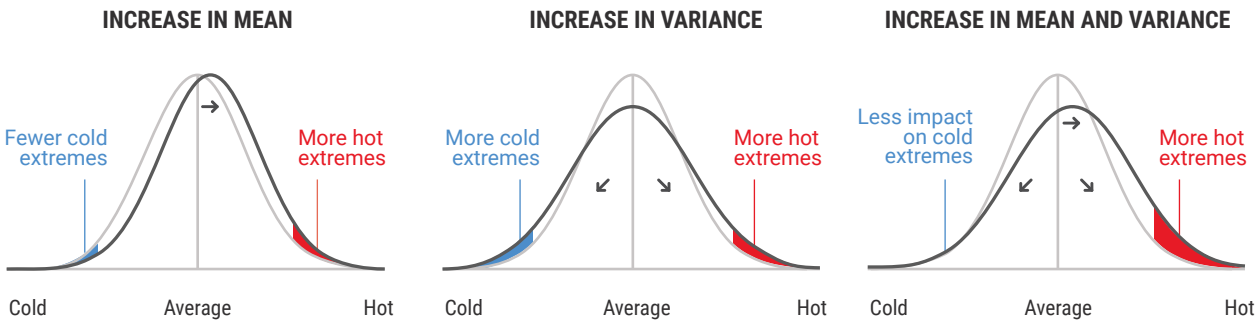
Across Libya, heatwaves, acute power cuts, continuous damage to the water system and the drying of the Wadi Kaam Dam pose acute threats to people's lives.

Credit: OCHA/Ahmed Rih

75. See for example: Mach, K and Siders, A.R. (18 June 2021). Reframing strategic, managed retreat for transformative climate adaptation. Science 372, 6548. doi: 10.1126/science.abh1894

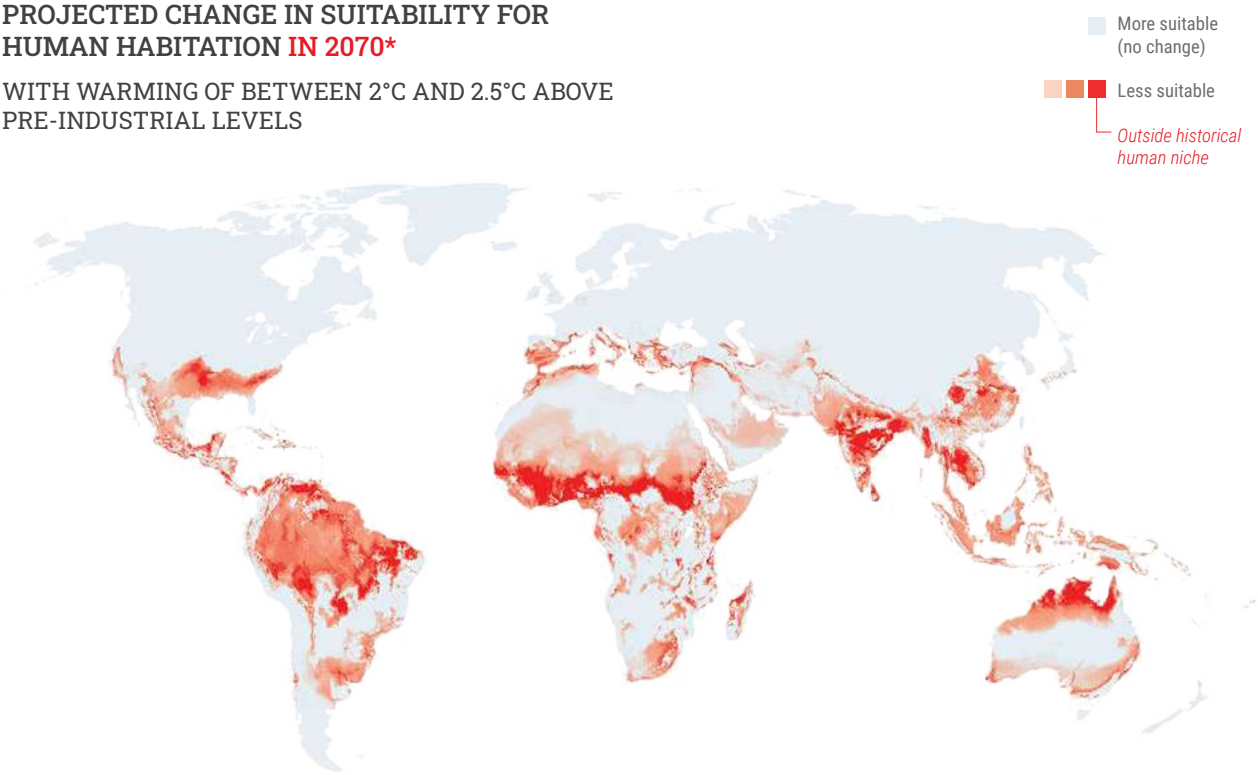
76. IPCC, 2019: Summary for Policymakers. In: IPCC Special Report on the Ocean and Cryosphere in a Changing Climate [H.-O. Pörtner, D.C. Roberts, V. Masson-Delmotte, P. Zhai, M. Tignor, E. Poloczanska, K. Mintenbeck, A. Alegría, M. Nicolai, A. Okem, J. Petzold, B. Rama, N.M. Weyer (eds.)]. Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 3–35. doi.org/10.1017/9781009157964.001

EFFECT OF CHANGES IN GLOBAL TEMPERATURE



PROJECTED CHANGE IN SUITABILITY FOR HUMAN HABITATION IN 2070*

WITH WARMING OF BETWEEN 2°C AND 2.5°C ABOVE PRE-INDUSTRIAL LEVELS



** Based on temperatures and precipitation levels*
Source: IPCC AR5; "Future of the human climate niche", by Chi Xu et al., 2020
The Economist's artwork based on the article and annex:
www.pnas.org/doi/suppl/10.1073/pnas.1910114117/suppl_file/pnas.1910114117.sapp.pdf

Fatuma Ankle, 20, stands next to livestock carcasses in Ethiopia's Somali Region.

Credit: FAO/ Michael Tewelde

5. EXTREME HEAT WILL HAVE CASCADING IMPACTS, THREATENING NON-HUMAN LIFE, AND UNDERMINING THE SYSTEMS THAT KEEP PEOPLE HEALTHY AND ALIVE

Heatwaves are a present and growing danger to human health, but the impacts do not stop there. Periods of extreme heat can cause severe damage to non-human life and ecosystems. These impacts are of concern not only in themselves but also because of their indirect effect on people and communities, as they undercut the infrastructure and ecosystems that keep us healthy and alive.

Climate and crops

The impact of climate change on agriculture is a complex topic with significant variation between regions of the world. Any analysis depends on a wide variety of factors and their interactions.[77] In some parts of the world, rising mean temperatures are projected to account for significant increases in certain crop yields, although these tend to be in areas of lower current food insecurity, including parts of northern North America and Russia. In many other regions,

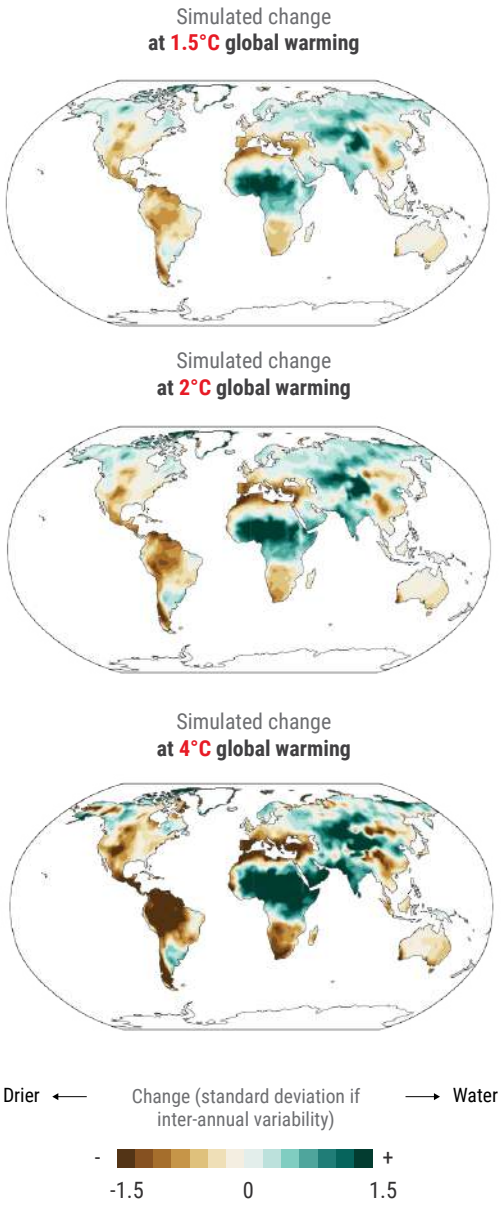
77. Siebert, S., Ewert, F. (2014). Future crop production threatened by extreme heat. Environmental Research Letters, 9(4). iopscience.iop.org/article/10.1088/1748-9326/9/4/041001

SOIL MOISTURE CHANGE

ANNUAL MEAN TOTAL COLUMN SOIL MOISTURE CHANGE (STANDARD DEVIATION)

Across warming levels, changes in soil moisture largely follow changes in precipitation but also show some differences due to the influence of evapotranspiration.

Relatively small absolute changes may appear large when expressed in units of standard deviation in dry regions with little inter-annual variability in baseline conditions



Source: Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M. I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T. K. Maycock, T. Waterfield, O. Yelekçi, R. Yu and B. Zhou (eds.)]. (2021). Climate Change 2021 The Physical Science Basis Summary for Policymakers. IPCC. www.ipcc.ch/report/ar6/wg1/

including those most relevant for current humanitarian need, the IPCC projects rising mean temperatures to account for significant decreases in some critical crops.[78]

Climatologists and agricultural professionals are working to understand how rising mean temperatures will impact agriculture (the chronic problem) as well as the impact of periods of extreme heat (the acute problem). And there is growing evidence that extreme-heat events can produce significant reductions in agricultural yields, particularly when they strike at a critical phenological stage.[79]

A study published in 2021 reviewing a global data set spanning 1979 to 2016 shows significant agricultural losses from past periods of extreme heat. Taking into account the impact of temperature extremes rather than mean temperature increases resulted in reductions in projected output that were up to 5–10 times larger.[80] Efforts are under way to improve crop models' ability to better understand these impacts.

Extreme-heat events can threaten food security by constraining global supply and contributing to price volatility for staple crops, such as wheat. Some research suggests an enhanced risk of concurrent extreme-heat events in several major breadbasket regions in different parts of the world, with significant projected impacts on global food security.[81]

78. See, for example, IPCC projection maps available here: report.ipcc.ch/ar6wg2/pdf/IPCC_AR6_WGII_Annex-I.pdf

79. Zampieri, M., et al. (2017, June 5). Wheat yield loss attributable to heat waves, drought and water excess at the global, national and subnational scales. Environmental Research Letters, 12(6). iopscience.iop.org/article/10.1088/1748-9326/aa723b/meta

80. Miller, S., et al. (2021, February 22). Heat Waves, Climate Change, and Economic Output. Oxford Academic, 19(5). doi.org/10.1093/jeea/jvab009

81. Kornhuber, K., et al. (2019, December 9). Amplified Rossby waves enhance risk of concurrent heatwaves in major breadbasket regions. Nature Climate Change, 10(48-53). www.nature.com/articles/s41558-019-0637-z

Extreme-heat events can also result in concentrated disruptions to the production of locally important staple crops. These local impacts could drive humanitarian needs, particularly where they are felt by smallholders who lack access to adaptations such as irrigation or heat-resistant varietals. One 2011 study of African maize yields found that each day spent above 30°C reduced the final yield by an average of one per cent under optimal rain-fed conditions and 1.7 per cent under drought conditions.[82] Another study of African maize yields shows that incorporating the impact of extreme events such as heat and drought reduced simulated yields by between nine and 21 per cent when compared to the impact of gradual changes alone.[83]

It will be critical that efforts to adapt agriculture to higher temperatures – for example by changing cropping patterns and adopting heat-sensitive crop varieties – also counter the impact of rarer, extremely high heat events. Given that agricultural workers are among those most highly exposed to extreme heat, it will also be critical to better understand how reduced labour productivity during heatwaves will interact with reduced crop yields, leading to compounded economic and human impacts and greater loss and damage.

Livestock, fisheries and food security

The health and productivity of livestock are critical to food security, nutrition and livelihoods for billions of people. Interventions such as animal vaccinations, destocking and veterinary care are a familiar facet of development and humanitarian programming, including in pastoral settings that have seen some of the most serious humanitarian needs in recent decades.[84]

But as with agriculture, periods of extreme heat can compromise the systems that keep animals healthy and alive. Extreme heat depresses feed intake, milk production and reproduction in cows[85] and, to a lesser extent, small ruminants such as sheep and goats.[86] In East Africa, a recent study found that the impact of extreme-heat events on livestock has increased significantly in the past three decades. It found that livestock production is likely to be severely compromised by more frequent and severe extreme-heat events in the future.[87]

Marine capture fisheries – a cornerstone of livelihoods and nutrition for many coastal communities and indigenous people – are particularly susceptible to marine heatwaves.[88] These events have grown in severity and frequency over the past decades and are projected to increase significantly with future climate change.[89] For example, the 'heat dome' over British Columbia in 2021 may have killed up to one billion marine animals.[90] In coastal communities in India,

82. Lobell, D., Bänziger, M., Magorokosho, C. et al. (2011). Nonlinear heat effects on African maize as evidenced by historical yield trials. Nature Climate Change, 1(42–45). doi.org/10.1038/nclimate1043

83. FAO. (2021). The impact of disasters and crises on agriculture and food security: 2021. Food and Agriculture Organization of the United Nations, 211. doi.org/10.4060/cb3673en

84. FAO. (2016). Livestock-related interventions during emergencies - The how-to-do-it manual. FAO Animal Production and Health Manual No. 18. www.fao.org/3/i5904e/I5904E.pdf

85. Temple, D., Bargo, F., Mainau, E., Ipharraguerre, I., & Manteca, X. (2015, May). Heat Stress and Efficiency in Dairy Milk Production: A Practical Approach. Farm Animal Welfare Education Centre. www.fawec.org/media/com_lazypdf/pdf/fs12-en.pdf

86. Froehlich, K., Quintana, J., & Carroll, H. (2021, November 18). Heat Stress in Small Ruminants. South Dakota State University Extension. extension.sdstate.edu/heat-stress-small-ruminants

87. Rahimi, J., et al. (2021, February 18). Heat stress will detrimentally impact future livestock production in East Africa. Nature Food, 2(2). www.nature.com/articles/s43016-021-00226-8

88. FAO. (2021). The impact of disasters and crises on agriculture and food security: 2021. Food and Agriculture Organization of the United Nations, 211. doi.org/10.4060/cb3673en

89. Oliver, E.C.J., Donat, M.G., Burrows, M.T. et al. (2018). Longer and more frequent marine heatwaves over the past century. Nature Communications, 9(13). doi.org/10.1038/s41467-018-03732-9

90. Cecco, L. (2021, July 8). 'Heat dome' probably killed 1bn marine animals on Canada coast, experts say. The Guardian. www.theguardian.com/environment/2021/jul/08/heat-dome-canada-pacific-northwest-animal-deaths

West Africa and elsewhere, marine heatwaves can devastate the habitat of shrimp and other wild and farmed fisheries that are a mainstay of local economies and diets.

Wildfire

Periods of extremely hot, dry and windy conditions – sometimes referred to as 'fire weather' – are responsible for the majority of the world's burned area.[91] One study found that in the last 20 years, the number of days that people are exposed to very high or extremely high risk of wildfires has increased in 114 countries.[92] The largest increases were in Kenya, Lebanon and South Africa. The occurrence of extreme fire weather is projected to continue increasing rapidly due to climate change; some climatologists project a 20–50 per cent increase in days conducive to wildfire in fire-prone areas.[93]

Wildfires can threaten lives and livelihoods, including by causing acute or chronic health issues, destroying infrastructure, and degrading water supply, nutrition and biodiversity. In 2019, the international disasters database, EM-DAT, recorded 14,569 people affected by wildfires around the world.[94]

Most recorded wildfires with significant human impact were in high-income countries, particularly Australia and North America. But it would be a mistake to think of the rising risk of wildfires as a problem only for those countries. 2017–2020 saw bigger increases in wildfire exposure in lower-income countries than in higher-income countries.[95] For example, wildfires fuelled by a heatwave across 17 provinces in northern Algeria in 2021 killed at least 69 people and displaced thousands, prompting a massive national aid effort and offers of logistical support from France and Morocco.[96] In Indonesia, extensive wildfires in 2015 contributed to more than 500,000 acute respiratory infections and to school closures that affected five million children. The immediate health costs were estimated at $151 million.[97]

Wildfire risks will continue to escalate. Climate models project increasing fire weather not only in the higher latitudes but in other regions of greater historical concern to development and humanitarian actors, including Southern Africa and Central Asia.

Of particular note to humanitarian actors is the potential for wildfire to combine with other hazards, multiplying their impacts. An obvious example is the intersection of fire and heatwaves. The day after the town of Lytton, British Columbia, set an all-time Canadian record with a staggering 49.6°C in June 2021, it was destroyed by wildfire *(also see graphic on pg. 28)*.

91. Jain, P., Castellanos-Acuna, D., Coogan, S.C.P. et al. (2022). Observed increases in extreme fire weather driven by atmospheric humidity and temperature. Nature Climate Change, 12(63–70). doi.org/10.1038/s41558-021-01224-1

92. Watts, N., Amann, M., Arnell, N., Ayeb-Karlsson, S., Beagley, J., Belesova, K., Boykoff, M., Byass, P., Cai, W., Campbell-Lendrum, D., Capstick, S., Chambers, J., Coleman, S., Dalin, C., Daly, M. Dasandi, N., Dasgupta, S., Davies, M., Di Napoli, C., … Costello, A. (2020, December 2). The 2020 report of the Lancet Countdown on health and climate change: responding to converging crises. The Lancet, 397(10269), 129-170.

93. Bowman, D., Williamson, G., Abatzoglou, J. et al. (2017). Human exposure and sensitivity to globally extreme wildfire events. Nature Ecology and Evolution, 1(0058). doi.org/10.1038/s41559-016-0058

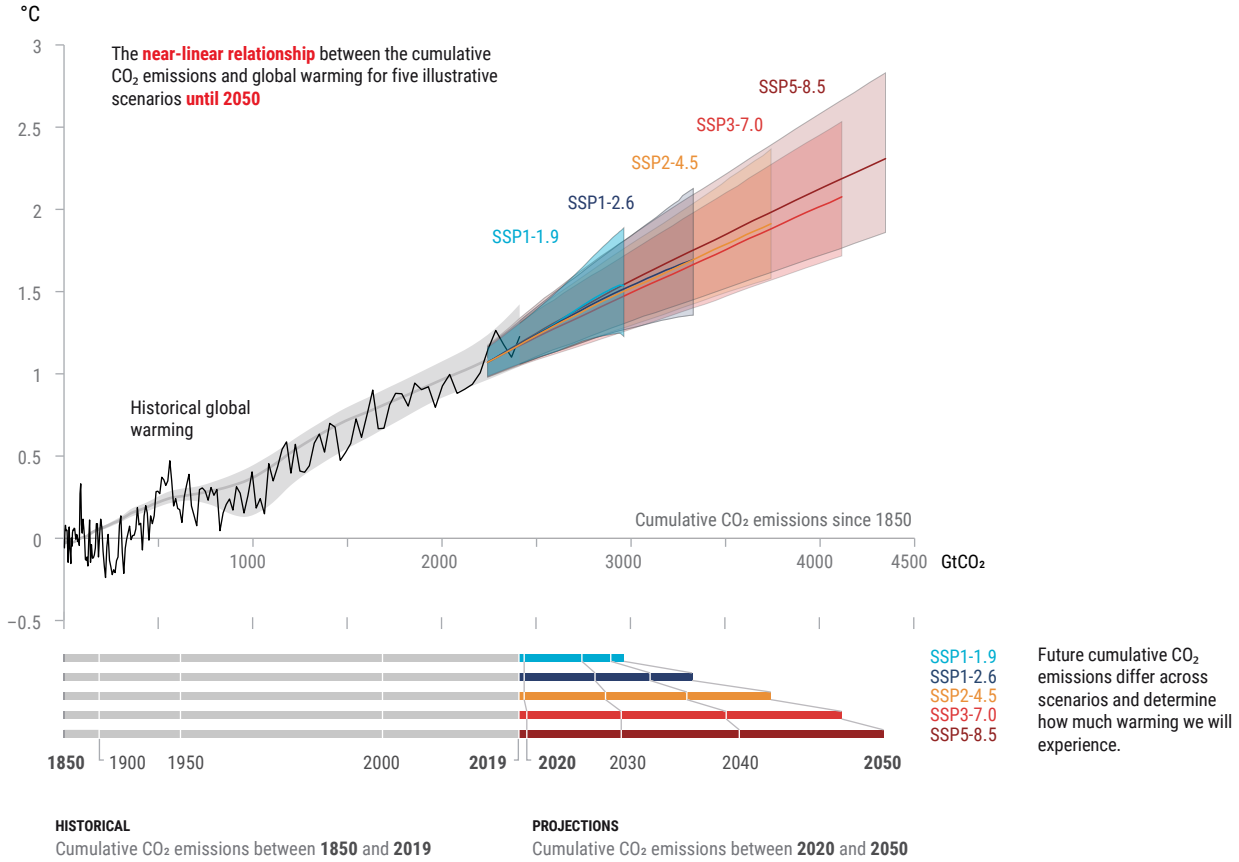
94. World Disasters Report 2020: Come Heat or High Water - Tackling the Humanitarian Impacts of the Climate Crisis Together. International Federation of Red Cross and Red Crescent Societies. reliefweb.int/sites/reliefweb.int/files/resources/20201116_WorldDisasters_Full_compressed.pdf

95. Romanello, M., et al. (2021, October 20). The 2021 report of the Lancet Countdown on health and climate change: code red for a healthy future. The Lancet, 398(10311). doi.org/10.1016/S0140-6736(21)01787-6

96. Al Jazeera and news agencies. (2021, August 21). Algeria observes day of mourning after dozens killed in wildfires. Al Jazeera. www.aljazeera.com/news/2021/8/12/algeria-observes-day-of-mourning-as-wildfires-keep-raging

97. UN Environment Programme. (2022, February 23). Spreading like Wildfire: The Rising Threat of Extraordinary Landscape Fires. A UNEP Rapid Response Assessment. www.unep.org/resources/report/spreading-wildfire-rising-threat-extraordinary-landscape-fires

GLOBAL SURFACE TEMPERATURE INCREASE SINCE 1850–1900 (°C) AS A FUNCTION OF CUMULATIVE CO_2 EMISSIONS ($GtCO_2$)



Top panel: Historical data (thin black line) shows observed global surface temperature increase in °C since 1850–1900 as a function of historical cumulative carbon dioxide (CO_2) emissions in $GtCO_2$ from 1850 to 2019. The grey range with its central line shows a corresponding estimate of the historical human-caused surface warming (see Figure SPM.2). Coloured areas show the assessed very likely range of global surface temperature projections, and thick coloured central lines show the median estimate as a function of cumulative CO_2 emissions from 2020 until year 2050 for the set of illustrative scenarios (SSP1-1.9, SSP1-2.6, SSP2-4.5, SSP3-7.0, and SSP5-8.5; see Figure SPM.4). Projections use the cumulative CO_2 emissions of each respective scenario, and the projected global warming includes the contribution from all anthropogenic forcers. The relationship is illustrated over the domain of cumulative CO_2 emissions for which there is high confidence that the transient climate response to cumulative CO_2 emissions (TCRE) remains constant, and for the time period from 1850 to 2050 over which global CO_2 emissions remain net positive under all illustrative scenarios, as there is limited evidence supporting the quantitative application of TCRE to estimate temperature evolution under net negative CO_2 emissions.

Bottom panel: Historical and projected cumulative CO_2 emissions in $GtCO_2$ for the respective scenarios.

Source: Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. World Bank. (2020). Climate Change 2021: The Physical Science Basis - Summary for Policymakers. Intergovernmental Panel on Climate Change. www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

Fire hazards related to extreme heat can also compound people's suffering in conflict. In Syria, wildfires in Homs, Latakia and Tartous in 2020 displaced up to 25,000 people, causing significant direct health impacts and the suspension of vaccination campaigns.[98]

98. United Nations Office for the Coordination of Humanitarian Affairs. (2020, October 11). OCHA Syria: Flash Update #01: Humanitarian Impact of Wildfire in Coastal Areas. United Nations. reliefweb.int/sites/reliefweb.int/files/resources/OCHA%20Syria%20Flash%20Update%20Fires%20in%20Coastal%20Areas%20as%20of%2011%20October.pdf

Scorched-earth tactics in conflict can dangerously coincide with heatwaves. Deliberate burning of crops during heatwaves has been alleged in the Syrian conflict and in Iraq.[99]

Damage to critical infrastructure

Cities highly exposed to extreme heat, such as Delhi, Jakarta, Khartoum and Kuwait, have seen explosive growth over recent decades. This has been enabled by traditional knowledge and practices that allow people to withstand occasional heatwaves. But it has also been enabled by infrastructure: water and sanitation facilities, electrical grids, and communications and transport networks that are themselves fragile and exposed. As extreme temperatures reach new and unprecedented highs and affect regions where they are unfamiliar, the resilience of this infrastructure should not be taken for granted.

Abrupt changes in vulnerability, including those caused by infrastructure failures, can also be catalysts for heat-related emergencies. Such failures can have an outsized humanitarian impact when they coincide with extreme heat. One example is the electricity crisis in Gaza during a severe heatwave in 2017, which contributed to diarrhoea cases among children more than doubling.[100]

Extreme heat can itself pose a threat to critical infrastructure precisely when it is needed most. Examples include the heatwave-related blackouts that imperiled Buenos Aires' water-purification system in January 2022,[101] and the European heat-

Paris is now one of several cities across Europe that frequently experiences record-breaking temperatures.

Credit: AFP/ Bertrand GUAY

99. See for example: Torching And Extortion: OSINT Analysis Of Burning Agriculture In Iraq - bellingcat; The New Humanitarian | As crops burn in Syria conflict zone, hunger warnings for civilians

100. UNICEF - State of Palestine. (2017, August 21). Amid scorching heatwave, access to water and electricity down by one-third in the Gaza Strip. UNICEF. unicef.org/sop/press-releases/amid-scorching-heatwave-access-water-and-electricity-down-one-third-gaza-strip

101. BAE Business. (2022, January 13). Heat wave: Aysa called for the "rational use" of water. BAE NEGOCIOS. www.baenegocios.com/sociedad/Ola-de-calor-Aysa-pidio-el-uso-racional-del-agua--20220113-0106.html

wave of 2003 that forced the shutdown of over 30 nuclear reactors because of cooling constraints.[102]

Refrigeration, cold storage and other power-dependent facilities are also vulnerable during extreme-heat events, posing serious risks to the value chains critical to millions of smallholder farmers and to humanitarian interventions, such as vaccinations.

A final, sobering possibility is that of a cyberattack or a physical attack on vital infrastructure during a severe heatwave aiming, for example, to cause a prolonged blackout. While terrible to contemplate, such an attack on a highly exposed major city could precipitate a mass-casualty event. This possibility should be planned for and not discounted.

Delays and disruptions to humanitarian response

If infrastructure failures can turn heatwaves into emergencies, they have the potential to disrupt efforts to respond to those emergencies.

Extreme heat or smoke from wildfires can make air travel difficult or impossible[103] and cause buckling in road and rail links used to transport relief items. A power outage or the direct impact of extreme heat can compromise the communication networks that allow humanitarian actors to share vital public health information and coordinate their operations.[104]

As with other hazards, humanitarian actors need to develop strategies to prevent infrastructure failures related to extreme heat from disrupting life-saving operations.

Climate and conflict

Establishing a direct relationship between extreme heat and organized armed conflict is a complex issue to be approached with caution. While climate stressors should not be said to cause conflict, they can add to a volatile mix of political and socioeconomic factors that increase fragility and ultimately make conflict more likely.[105] When it comes to extreme heat, these drivers include disruptions to livelihoods, food price increases, displacement and heightened competition for scarce resources, such as water and pasture.

When conflicts do occur, they can vastly increase people's exposure to heat risks and undermine their coping capacities. The destruction of shelter and damage to life-sustaining health and water systems that often accompany conflicts – particularly in urban environments – dramatically increase the risks associated with heatwaves.

So too does forced displacement. People are vulnerable to heatwaves when they are on the move but also when they reach areas of displacement or resettlement. The majority of the world's refugees are in cities, and twice as many IDPs are in urban environments than in non-urban environments.[106] Refugees and IDPs frequently settle temporarily in the vast informal and often off-grid settlements that characterize many cities in or near conflict areas. As discussed above, people in these settlements are particularly vulnerable to heatwaves because of elevat-

102. Schaar, J. (2021). Addressing Climate-Related Security Risks in the Middle East and North Africa. United Nations Political and Peacebuilding Affairs. dppa.un.org/sites/default/files/200624_mena_report_final_0.pdf

103. Nemo, L. (2021, May 3). Why Extreme Heat Might Cancel Your Flight. Discover. www.discovermagazine.com/environment/why-extreme-heat-might-cancel-your-flight

104. Weir, R. F., (2022). Heat and Power Problems are the Greatest Risks to Telecom Equipment. HSB Group. www.hsb.com/TheLocomotive/HeatAndPowerProblemsAreTheGreatestRisksToTelecomEquipment.aspx

105. See for example UNEP's work on climate action and conflict: www.unep.org/news-and-stories/story/climate-action-holds-key-tackling-global-conflict

106. The UN Refugee Agency. (2021, June 18). Global Trends: Forced Displacement in 2020. United Nations High Commissioner for Refugees. www.unhcr.org/en-us/statistics/unhcrstats/60b638e37/global-trends-forced-displacement-2020.html

ed temperatures, crowded conditions, lack of cooling options, and limited access to health information and basic services. This dangerous combination of factors is also present in many refugee and IDP camps.

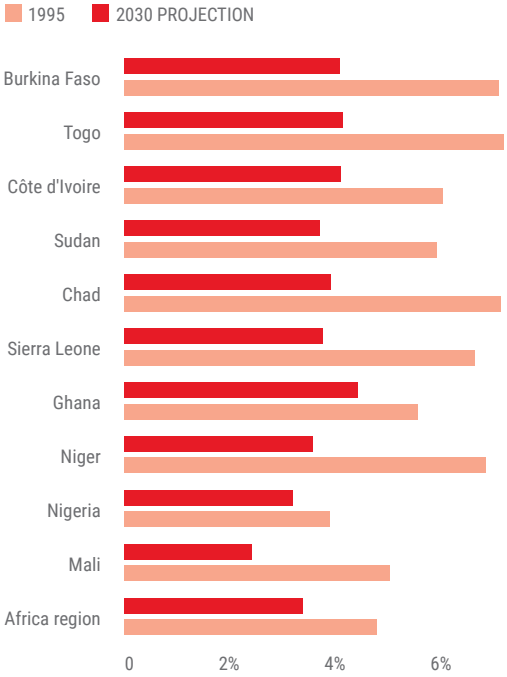
Extreme heat can also drive forced displacement and migration in its own right. Here, too, caution must be exercised in drawing direct causal links, as the decision to move is often an anguished and complex one that involves a mix of interconnected factors. But there can be no question that the direct and indirect impacts of extreme heat will contribute to greater human mobility and displacement in the future. The Internal Displacement Monitoring Centre recorded 1.1 million new internal displacements that it linked to extreme temperatures (mostly extreme cold) between 2008 and 2020. It also linked 3.4 million displacements to wildfires in this period, 90 per cent of them in the Americas.[107]

Beyond these acute episodes of displacement associated with particular events, extreme heat will contribute to longer-term accelerating changes in ecosystems and economies that push people to move permanently. The International Organization for Migration (IOM) anticipates that long-term shifts in the habitability of a number of regions due to heat stress will result in reshaped and increasing migration flows. Research that IOM commissioned in 2017 projects that by the end of the century, even under 1.5°C of warming, 30 million to 60 million people will live in areas where the average heat in the hottest month will be too high for the human body to function well. Under a 2°C rise this increased to 100 million people, with the impacts greatest in tropical low- and middle-income countries.[108]

Heat-damaged economies

PERCENTAGE OF WORKING HOURS LOST TO HEAT STRESS UNDER A 1.5°C GLOBAL WARMING SCENARIO

TEN MOST AFFECTED COUNTRIES IN AFRICA



Source: International Labour Organization (2019). Working on a warmer planet: The impact of heat stress on labour productivity and decent work. www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf

Building resilience to climate-related extreme events is a core component of the Sustainable Development Goals (SDGs) and the 2030 Agenda.[109] If investments in achieving the resilience-related SDGs are not dramatically scaled up, the achievement of the entire Agenda will be threatened by reduced food security and degraded infrastructure related to extreme heat, and also by job losses and decreases in labour

107. Internal Displacement Monitoring Centre. (2021). Grid 2021: Internal displacement in a changing climate. Internal Displacement Monitoring Centre. www.internal-displacement.org/sites/default/files/publications/documents/grid2021_idmc.pdf

108. Chazalnoel, M. T., Mach, E., Ionesco, D., et al. (2017). Extreme Heat and Migration. International Organization for Migration. environmentalmigration.iom.int/sites/g/files/tmzbdl1411/files/Infosheet%20Heat%20and%20Migration%20july%2028th%202017.pdf

109. See for example: SDGs 1.5, 2.4, 11b and 13.

productivity in highly exposed countries and sectors.

These impacts are being felt already. In 2020, an estimated 295 billion work-hours were lost due to extreme heat. The International Labour Organization (ILO) projects that economic losses related to heat stress will rise from $280 billion in 1995 to $2.4 trillion in 2030, with lower-income countries, including those in West Africa and South Asia, seeing the biggest losses. These regions are projected to lose around five per cent of their work-hours by 2030, corresponding to around 43 million full-time jobs.[110] One study found that a large percentage of the global cost of reducing carbon emissions could be offset by these losses in worker productivity due to extreme heat.[111]

As with other extreme-heat impacts, this economic damage is extremely unequal in geographic and socioeconomic terms. Impacts are concentrated in countries with the largest deficits of decent work and among communities with the fewest means to reduce their occupational exposure.[112] The economic impacts of rising extreme heat will challenge the commitment in the SDGs to 'leave no one behind,' reducing the capacity of the most vulnerable people to absorb other shocks and increasing their likelihood of falling into humanitarian need.

110. Working on a Warmer Planet: The impact of heat stress on labour productivity and decent work. (2019). International Labour Organization. www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf

111. Orlov, Sillmann et. al. (2020). Economic costs of heat-induced reductions in worker productivity due to global warming. Global Environmental Change. 63: 102087.

112. See for example this analysis of disproportionate impact of heat stress on Black and Hispanic workers in the United States: www.atlanticcouncil.org/wp-content/uploads/2021/08/Extreme-Heat-Report-2021.pdf

PART TWO

PREDICT, PREVENT, RESPOND

The analysis in the previous sections paints a grim picture of a future of increasing extreme heatwaves that cause widespread suffering and overwhelm coping capacities – what might be termed 'heat disasters.' But this future is not inevitable. If aggressive investments are made in mitigation and adaptation, heat disasters can be preventable, predictable and actionable.

Heat disasters are preventable

Reduce greenhouse gas emissions

The most important thing that can be done to prevent a future of large-scale heat disasters is to honour the commitment to keep global warming well below 2°C. Each incremental increase in mean warming will result in outsized increases in the frequency and intensity of heatwaves, with massive consequences for their human impact.

The difference between a world at 1.5°C and a world at 2°C is immense – between these levels of warming the frequency of extreme heatwaves could double. One analysis shows that limiting global warming to 1.5°C compared to 2°C could result in up to 420 million fewer people being frequently exposed to extreme heatwaves and around 65 million fewer people being exposed to 'exceptional' heatwaves.[113]

The difference between 1.5°C and 2°C of warming is projected to be felt most acutely in the lowest-income countries.[114] Reducing emissions is the single most critical challenge, and humanitarians have a role to play in reducing the carbon footprint of their operations and making clear to policymakers and the public what is at stake.

Adapt to survive

The future impacts of extreme heat that cannot be prevented through mitigating climate change will either be absorbed by resilient and adaptive societies or result in increased suffering, loss and damage. Investing in development pathways that reduce vulnerability and build resilience to heat risk will be critical to meeting the SDGs.

Financing is a key barrier to maximizing adaptation and minimizing loss. But the challenge is immense for the countries at highest risk. Donor countries did not deliver on their commitment to fund adaptation at a minimum of $100 billion annually by 2020. Development financing that has been provided was dedicated in vanishingly small amounts – as little as 0.5 per cent – to strategies aimed specifically at disaster risk reduction.[115] IFRC found that none of the 20 most climate vulnerable countries were among the 20 highest per-person recipients of adaptation funding.[116] Correcting these imbalances is a critical step to prevent heatwaves becoming disasters.

When financial challenges can be overcome, there is no question that adaptation can yield important results. Development choices and investments can significantly reduce the death and suffering caused by extreme heat, even in the face of rising temperatures. Dozens of studies – albeit focused mostly on developed countries – show gradual, long-term reductions in the impact of extreme heat on human health in

113. Dosio, A., Mentaschi, L., Fischer, E. M., & Wyser, K. (2018, April 25). Extreme heat waves under 1.5°C and 2°C global warming. Environmental Research Letters, 13(5). iopscience.iop.org/article/10.1088/1748-9326/aab827

114. Russo, Sillmann, et. al (2019). Half a degree and rapid socioeconomic development matter for heatwave risk. Nature Communications. 10 (36).

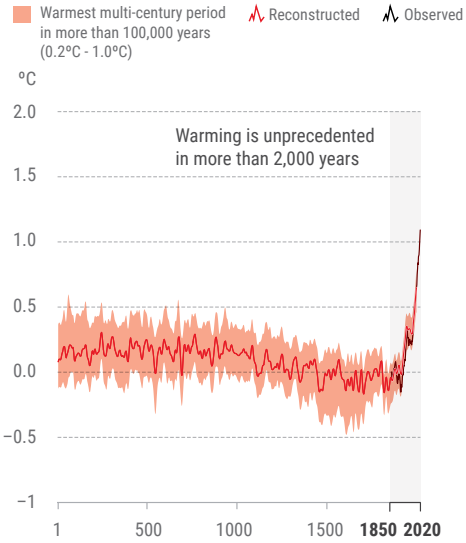
115. United Nations Office for Disaster Risk Reduction. (2021, October 13). High-Level Dialogue on International Cooperation to Scale Up Financing for DRR: Financing for Disaster Risk Reduction Makes Up a Tiny Fraction of Overall Investments in Development Aid. UNDRR. www.undrr.org/news/high-level-dialogue-international-cooperation-scaleup-financing-drr-financing-disaster-risk

116. World Disasters Report 2020: Come Heat or High Water - Tackling the Humanitarian Impacts of the Climate Crisis Together. International Federation of Red Cross and Red Crescent Societies.

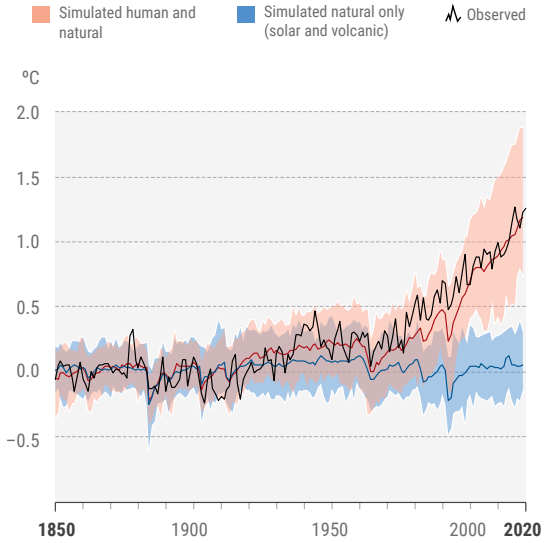
CHANGES IN GLOBAL SURFACE TEMPERATURE

HUMAN INFLUENCE HAS WARMED THE CLIMATE AT A RATE THAT IS UNPRECEDENTED IN AT LEAST THE LAST 2,000 YEARS

Change in global surface temperature (decadal average) as reconstructed (1–2000) and observed (1850–2020)



Change in global surface temperature (annual average) as observed and simulated using human and natural and only natural factors (both 1850–2020)



Source: Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. World Bank. (2020). Climate Change 2021: The Physical Science Basis - Summary for Policymakers. Intergovernmental Panel on Climate Change. www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

some contexts over recent decades.[117] Countries including Japan, Spain and the United States have seen measurable decreases in mortality. This success is likely due to many different factors working in combination, including public education, urban planning, adaptive social protection, access to services, improvements to shelter, and local emergency preparedness to respond to heat and compounded risks.

The same link between socioeconomic development and extreme-heat risk demonstrated in the past is projected to hold true in the future. Analyses of future heatwave risk demonstrate the huge impact that different socioeconomic pathways – including crucial reductions in inequality and slowed population growth – will have on the number of people who face extreme-heat risks as the climate warms.[118]

The optimum mix of adaptation interventions is highly context specific. Adaptation measures taken to date have varied considerably across regions. High-income

117. For a useful review of the relevant literature: Scott C Sheridan and Michael J Allen 2018 Environ. Res. Lett. 13 043001. See also: Gasparrini A, Guo Y, Hashizume M, Kinney PL, Petkova EP, Lavigne E, Zanobetti A, Schwartz JD, Tobias A, Leone M, Tong S, Honda Y, Kim H, Armstrong BG. 2015. Temporal variation in heat-mortality associations: A multicountry study. Environ Health Perspect 123:1200–1207; dx.doi.org/10.1289/ehp.1409070

118. Russo, Sillmann, et. al (2019). Half a degree and rapid socioeconomic development matter for heatwave risk. Nature Communications. 10 (36).

countries have tended to treat extreme heat primarily as a health issue, while adaptation in lower-income countries has focused more on the agricultural, livelihood and economic impacts.[119] Strategies that succeeded in Berlin and Tokyo cannot be simply transplanted to Dakar and Managua. But it is critical to capture the lessons of what worked so they can be applied in a context-appropriate way, especially to the most vulnerable areas. Significant efforts are already under way to do this, notably by different networks of cities (such as C40 Cities) and research partnerships (such as the Extreme Heat Resilience Alliance and Cool Infrastructures). These efforts should be supported and accelerated.

It is equally important to recognize that adaptation comes with risks and limits. Some of the steps that contributed to reduced mortality – such as increases in energy-intensive air conditioning – are expensive and ecologically unsustainable, and they themselves contribute to climate change. And the successes achieved to date have been in response to climate change levels that are modest compared to likely future scenarios.

If emissions are not aggressively reduced, future changes will bring previously unimaginable levels of extreme heat, and societies may face limits beyond which even the best-resourced efforts are unable to deliver effective adaptation for all.

Heat disasters are predictable

There is an increasing level of confidence in weather forecasts that provide early warning of particular heat events. Dangerous temperature extremes (including the especially dangerous high heat/high humidity combination) are among the most reliably predictable weather hazards.

Heatwaves are highly seasonal in most parts of the world. Where distinct annual cycles exist, local authorities' and civil society's preparedness efforts and resources can be focused on periods when they can have the greatest impact. Heatwaves are also highly forecastable. Although there are important differences between regions, predictability of heatwaves 3–10 days in advance using global models is generally high in the extra-tropics and more variable in the tropics, affording critical time to take early action where warning systems are in place.

Further investments are needed to increase forecasting skills, link projected weather more firmly to foreseen impacts, and make actionable information more readily available to people and decision makers at every level. But while these challenges remain critical, the meteorological tools are firmly in place to do much more, now. Indeed, a 2017 analysis found that almost five billion people live in regions where current forecasts are reliable enough to implement heatwave action plans to enhance preparedness.[120]

Heat disasters are actionable

Early warning systems

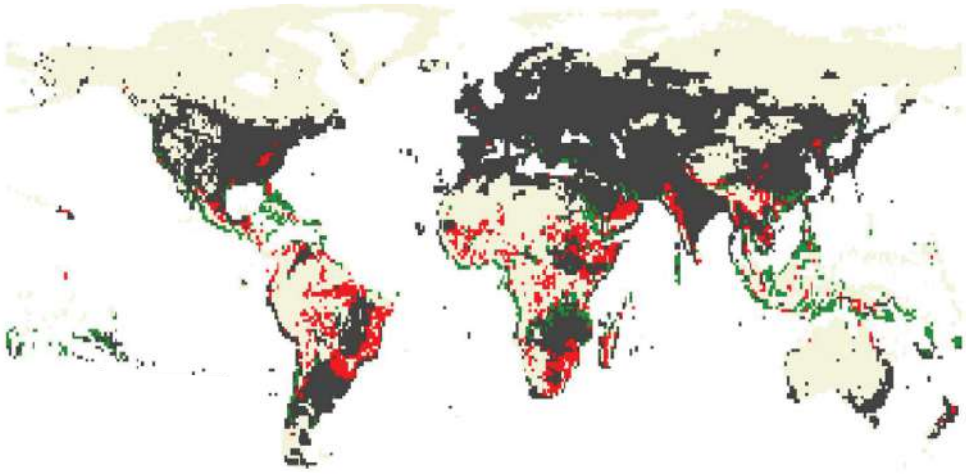
Heatwaves are among the most forecastable of weather extremes, which means relatively reliable systems can be established to alert communities, local authorities and service providers. Typically, warning systems should comprise the first component of a broader, multi-stakeholder action plan. They can be established at the national, regional or local level. Warning systems gen-

119. Turek-Hankins, L. L., de Perez, E. C., Scarpa, G., Ruiz-Diaz, R., Shwerdtle, P. N., Joe, E. T., Galappaththi, E. K., French, E. M., Austin, S. E., Singh, C., Siña, M., Siders, A. R., van Aalst, M. K., Templeman, S., Nunbogu, A. M., Berrang-Ford, L., Agrawal, T., the Global Adaptation Mapping Initiative Team, & Mach, K. J. (2021). Climate change adaptation to extreme heat: A global systematic review of implemented action. Oxford Open Climate Change, 1(1). doi.org/10.1093/oxfclm/kgab005

120. de Perez, E. C., van Aalst, M., Bischiniotis, K., Mason, S., Nissan, H., Pappenberger, F., Stephens, E., Zsoter, E., & van den Hurk, B. (2018). Global predictability of temperature extremes. Environmental Research Letters, 13(5). doi.org/10.1088/1748-9326/aab94a

TYPE OF PREPARATION POSSIBLE FOR HEATWAVES AROUND THE WORLD

No exposure or poor skill | Seasonal preparedness | Short-term forecasts | Both seasonal preparedness and short-term forecasts



Source: Coughlan de Perez et al. (2018) Global predictability of temperature extremes. Environmental Research Letters, 13. iopscience.iop.org/article/10.1088/1748-9326/aab94a/pdf

erally include a weather forecasting service that considers factors including maximum and minimum temperatures and humidity; a series of predetermined, locally appropriate thresholds for action linked to different levels of potential impact; and a graduated system of alerts for communication to the public and key stakeholders.

National meteorological agencies typically play a lead role in providing the forecasting services integral to an early warning system. However, where necessary these can be supplemented by global forecasting services, such as those operated by the National Oceanic and Atmospheric Administration of the United States, NASA Earth observations or the European Centre for Medium-Range Weather forecasts.

WHO and the World Meteorological Organization (WMO), which operate a Joint Office for Climate and Health, have developed comprehensive global guidance on heat-health warning systems, and they work together to support countries in adopting systems suited to their context.[121]

Critical to the future effectiveness of early warning systems will be providing forecasts that predict the real impact on people – moving beyond an analysis of what the weather will be to what the weather will do. Significant investments are being made in impact-based forecasts that combine meteorological and vulnerability information to produce an early analysis of both how and by whom the worst effects will be felt. These analyses have already enabled early action for heatwaves in different contexts, including Argentina and Vietnam, and there is significant potential for them to be rolled out to more countries. Humanitarian organizations can be both users and participants in the development of these systems.[122]

121. McGregor, G. R., Bessemoulin, P., Ebi, K., & Menne, B. (Eds.). (2015). In Heatwaves and health guidance on warning-system development. story, WMO and WHO.

122. Arctic Regional Resilience to Changing Climate, Met Office, Climate Centre, UK Aid, Anticipation Hub, Risk-informed Early Action Partnership. (2020). The future of forecasts: impact-based forecasting for early action. www.forecast-based-financing.org/wp-content/uploads/2020/09/Impact-based-forecasting-guide-2020.pdf

Early warning systems – including those that are impact based – should not, of course, be limited to forecasting heatwaves. Extreme heat should instead form one element of multi-hazard systems that share timely and actionable information with all relevant stakeholders[123] and link to context-specific action plans that are based on the type and severity of the forecast event.

A people-centred approach to early warning will continue to remain key. A community early warning system (CEWS) is an effort by or with a community to systematically collect, compile and/or analyse information that enables the dissemination of early warning messages that can help the community take action to reduce harm or loss from a hazard.[124]

CEWS are a key approach to contribute to community-based disaster risk management. As emergency alerts from national systems often do not reach everyone at risk, CEWS can help ensure that information and warnings reach and are actionable by the most vulnerable communities. Where and when national early warning systems are active, CEWS can complement governmental mandates to protect lives and livelihoods. Where they do not yet exist, CEWS serve to encourage dialogue about what national systems are required and how civil society actors and Red Cross and Red Crescent National Societies, as an auxiliary to Governments, may play a role in supporting them.

Government-led heat action plans

Once an early warning system sounds the alarm about a possible heatwave with significant human impacts, this should set in motion a series of pre-agreed actions aimed at mitigating the worst impacts of the event.

Heat action plans (sometimes referred to as heat-health action plans) combine these actions and provide a platform for collaboration and coordination among all actors relevant to heatwave response. In some cases, heat action plans go beyond the response to particular events to address longer-term efforts such as urban planning – a comprehensive approach that humanitarian actors should encourage and help promote.

Heat action plans need to be highly tailored to the particular climate, demographics, geography, infrastructure and socioeconomics of the communities they are designed to protect. For example, London's lowest threshold for action is based on a forecast maximum of 32°C; in Ahmedabad this is set at 41.2°C. Steps to take under a heat action plan can be tailored and targeted to the highest-risk groups – for example agricultural workers and the elderly – according to the event's projected impact.

Local conditions will dictate the plan's details, but practice in different parts of the world has demonstrated that certain core elements are indispensable. They include:[125]

- Agreement on a lead body to coordinate and provide a platform for collaboration, typically a Government agency. Ideally, the lead body should be linked to established national systems including national meteorological services, disaster risk management agencies and relevant sectoral actors.
- Clear links and communication channels between national and community early warning systems, from the early warning system to the early action platform, and from the early action platform to all relevant stakeholders.

123. World Meteorological Organization. (2021). WMO guidelines on Multi-hazard impact-based forecast and warning services. WMO.

124. See for example: www.ifrc.org/sites/default/files/CEWS-Guiding-Principles-EN.pdf

125. This analysis derived from expert interviews; from WHO Regional Office for Europe: "Heat and Health in the WHO European Region (2021)"; from Rajashree Kotharkar and Aveek Ghosh: "Progress in Extreme Heat Management and Early Warning Systems: A Systematic review of heat-health action plans 1995-2020"; and from doi.org/10.1016/j.scs.2021.103487

- Identification and analysis of particularly vulnerable groups and areas that need priority response.
- Agreed triggers and graduated thresholds for action based on locally appropriate metrics such as temperature, humidity, and the event's expected duration.
- Agreed appropriate early/anticipatory actions to reduce risks and protect people and livelihoods.
- Operational preparedness and readiness measures for local first responders.
- A robust public communications plan, including nationally harmonized, action-oriented key messages.[126]
- Real-time monitoring, evaluation and learning mechanisms.

Each plan's specific actions will depend on the projected severity and duration of the event but also on how far in advance the warning is given. Some actions possible with 10 days' notice may not be possible with shorter notice periods, e.g. modifications to shelter in the highest-risk areas or refresher training for health-care workers. Equally, actions will depend on the tools and capacities available in particular areas, such as the reach of the health-care system or the presence of public buildings or businesses that can be used as cooling centres.

Bearing in mind that plans will be highly locally specific, the following types of action can be included:

- Ensure public health promotion, early warning and information campaigns to alert people of the coming danger and the steps they can take to protect themselves and mitigate the risk of heat-related health conditions.
- Train caregivers in social facilities (nursing homes, orphanages) on protection measures, detection of relevant symptoms and management of cases.
- Provide clean water to the highest-risk areas (using sustainable means and avoiding single-use plastics).
- Distribute ice packs, oral rehydration salts or heat protection kits, including items such as umbrellas, towels and fans.[127]
- Establish preparedness measures within the health-care system, including stocking relevant medicines and IV fluids, and set up temporary outreach clinics in vulnerable areas.
- Designate shaded areas and cooling options, such as misting at gathering points, or use religious sites or other public spaces as cooling centres.
- Paint roofs white (or similar 'cool roofing' interventions) and take steps to improve passive ventilation in homes.
- Issue policy directives to suspend work, provide free public transport or amend working hours.
- Take steps to ensure continuous power to critical facilities, such as water purification.
- Target cash distributions or suspend utility and other payments.
- Protect crops and animals that communities rely on.
- Target care for the most vulnerable, e.g. visits from community health-care workers to pregnant women or elderly people living alone.

As the danger of extreme heat has grown in recent decades, heat action plans that bring together such actions have spread in many

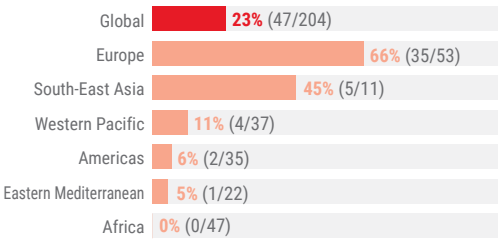
126. See for example: www.ifrc.org/document/public-awareness-and-public-education-disaster-risk-reduction-key-messages-2nd-edition

127. Fans as a heat-reduction intervention need to be used with caution and may compound risks in certain contexts, especially among the elderly: Havenith, G. (2016, September 7). Electric fans may not help the elderly in a heatwave. The Conversation. theconversation.com/electric-fans-may-not-help-the-elderly-in-a-heatwave-64834

parts of the world. Many of the earliest plans were in high-income countries, but since the WHO Regional Office for Europe issued the first guidance in 2008, plans have been adopted in at least 47 countries – with city governments often at the forefront.

In India, the National Disaster Management Agency is working with 23 states and over 100 cities to implement heat action plans.[128] In many cases in India and elsewhere, civil-society organizations (CSOs) and voluntary organizations are partnering with Governments to enhance vulnerability analysis, conduct outreach, and improve public communications and service provision.

DISTRIBUTION OF EXISTING HEAT ACTION PLAN AND HEAT-HEALTH ACTION PLAN



Source: Kotharkar, R. (2021). Progress in extreme heat management and warning systems: A systematic review of heat-health action plans (1995-2020). Sustainable Cities and Society, 76(103487). www.sciencedirect.com/science/article/abs/pii/S2210670721007538

A recent review of heat action plans from around the world found an encouraging acceleration of work in South-East Asia, the eastern Mediterranean and the Pacific. Worryingly, the review found that few low-income countries and no African countries had adopted such plans.[129] The review also found low rates of integration of heat plans with broader national health policies and disaster management plans, although they were more often related to national climate change adaptation plans.

The geographic imbalance and low rate of national policy integration of heat action plans are challenges that will require significant efforts to address. But there is plentiful evidence that these efforts can pay large dividends. Where action plans have been adopted and backed with adequate resources, they have a remarkable track record in saving lives. A recent high-quality study of mortality in the city of Ahmedabad, India, found that its groundbreaking heat action plan – the first in a developing country – has helped that city avoid over 1,100 deaths annually.[130] In France, the 2006 heatwave saw approximately 4,400 fewer deaths than would have been expected under similar conditions in 2003. This was due to steps taken in early warning, prevention and early action under the National Heat Wave Plan.[131] A similar study shows measurable reductions of mortality in Montreal, with a higher impact on elderly people and people in poorer neighbourhoods.[132]

128. NRDS International: India. (2020). Expanding heat resilience across India: heat action plan highlights. www.nrdc.org/sites/default/files/india-heat-resilient-cities-ib.pdf

129. Kotharkar, R., & Ghosh, A. (2021). Progress in extreme heat management and warning systems: A systematic review of heat-health action plans (1995-2020). Sustainable Cities and Society, 76. doi.org/10.1016/j.scs.2021.103487

130. Hess, J. J., LM, S., Knowlton, K., Saha, S., Dutta, P., Ganguly, P., Tiwari, A., Jaiswal, A., Sheffield, P., Sarkar, J., Bhan, S. C., Begda, A., Shah, T., Solanki, B., & Mavalankar, D. (2018). Building resilience to climate change: Pilot evaluation of the impact of India's first heat action plan on all-cause mortality. Journal of Environmental and Public Health, 2018. doi.org/10.1155/2018/7973519

131. Fouillet, A., Rey, G., Wagner, V., Laaidi, K., Empereur-Bissonnet, P., Le Tertre, A., Frayssinet, P., Bessemoulin, P., Laurent, F., De Crouy-Chanel, P., Jougla, E., & Hémon, D. (2008). Has the impact of heat waves on mortality changed in France since the European Heat Wave of summer 2003? A study of the 2006 heat wave. International Journal of Epidemiology, 37(2). doi.org/10.1093/ije/dym253

132. Benmarhnia, T., Bailey, Z., Kaiser, D., Auger, N., King, N., & Kaufman, J. S. (2016). A difference-in-differences approach to assess the effect of a heat action plan on heat-related mortality, and differences in effectiveness according to sex, age, and socioeconomic status (Montreal, Quebec). Environmental Health Perspectives, 124(11). doi.org/10.1289/ehp203 Health Perspect 124:1694–1699; dx.doi.org/10.1289/EHP203

The unbearable conditions of summer weigh heavily on displaced families living in camps in north-west Syria.Credit: OCHA/Abdul Aziz Qitaz

With the right investments and adjustments for each context, this type of success can and should be brought to more low-income countries, including in current humanitarian settings.

Cities are on the front lines of this public health emergency and are thus crucial in leading the fight to prevent unnecessary deaths from heat. City staff can and should also work with partners to consolidate heat action plans and adapt urban planning practices.[133]

Don't wait — anticipate

The humanitarian sector is increasing its use of anticipatory action, whereby it releases funding and initiates early action before disaster strikes, based on pre-agreed triggers and plans. This practice is extremely well suited to heatwaves and to compound disasters involving heat and other hazards.

Effective response modalities for heatwaves lend themselves well to early action. Public education campaigns, expanding access to cool water and designating cooling centres are all 'no regrets' steps that can be taken with relatively short notice. If the life-saving benefits of early response to heatwaves are to be extended to more low-income environments and current emergency settings, it is critical that humanitarian actors take up the challenge of expanding the anticipatory approach.

Encouraging steps have already been taken in that direction. IFRC, working closely with National Red Cross and Red Crescent Societies and local partners, has used its Disaster Response Emergency Fund's forecast-based action window to fund pre-agreed early action protocols for extreme heat in Kyrgyzstan, Tajikistan and Vietnam. These plans include awareness-raising activities, setting up cooling centres, providing ser-

133. Singh, R., Arrighi, J., Jjemba, E., Strachan, K., Spires, M., Kadihasanoglu, A., Heatwave Guide for Cities (2019). Red Cross Red Crescent Climate Centre. www.ifrc.org/sites/default/files/2019_RCCC-Heatwave-Guide-for-Cities_ONLINE-copy.pdf

vices to Government-run care facilities for elderly people and children, and livelihoods support to vulnerable families to avoid prolonged exposure to heat.

In Pakistan, a number of local NGOs in several cities in the south are working with the support of pre-positioned financing through the Start Ready Fund, implementing multi-layered contingency plans activated by pre-agreed triggers related to extreme heat.

At the most local of levels, local actors such as Red Cross Red Crescent staff and volunteers are on the front lines of extreme heat in towns and cities around the world. It is important that they understand the heat risks they face, work with officials and partners to prepare for heat action, and integrate simple, low-cost, life-saving actions into routine activities.[134]

As these efforts expand to include more actors with different financing sources in different places, the issue of coordination becomes all the more important. In the projects noted above, local partners are working hard to embed and coordinate their anticipatory programmes with broader action plans led by local government. Where there is more than one humanitarian actor in a given area implementing anticipatory approaches (which will increasingly be the case), these projects should be coordinated with government but also with one another. The more that data, forecasts, triggers and thresholds for action can be shared and harmonized, the more efficient and effective these approaches will be. Humanitarian coordination will have an important role in ensuring these synergies, but the critical factor in the longer term is ownership and leadership by local governments.

Adaptive social protection

Social protection schemes are broadly understood as social assistance, social insurance and labour market interventions aimed at providing a social safety net. They can be a critical tool in building resilience to disasters, including those related to climate change. By contributing to improvements in health and reductions in poverty and inequality, social protection can help address vulnerabilities to extreme heat and other climate risks.

The expansion of social protection schemes in higher-income countries has likely played a role in the reduction of heat-related mortality observed in some contexts in recent decades. During a heatwave, people who lack access to the security afforded by social protection have few options but to expose themselves to heat, and they have less access to services that can help mitigate the impacts.

In times of extraordinary disruption, social protection schemes can be adapted to provide additional or different forms of support. In response to shocks, they can be expanded either horizontally to increase the number of people covered, or vertically to increase or change the assistance provided. In response to the COVID-19 pandemic, over 200 countries and territories have planned or implemented expanded social protection measures, aiming to reach over 2.4 billion people.[135]

There is strong evidence of the cost-effectiveness of these schemes[136] and of their suit-

134. Arrighi, J., Singh, R., Khan, R., Koelle, B., Jjemba, E., City Heatwave Guide for Red Cross Red Crescent Branches (2020). Red Cross Red Crescent Climate Centre. www.ifrc.org/sites/default/files/2019_RCCC-Heatwave-Guide-for-RCRC-Branches-1.pdf

135. World Bank. (2021). Social protection and jobs responses to covid-19: a real-time review of country measures. documents1.worldbank.org/curated/en/281531621024684216/pdf/Social-Protection-and-Jobs-Responses-to-COVID-19-A-Real-Time-Review-of-Country-Measures-May-14-2021.pdf

136. See for example: Cabot-Venton, C. (2018). Economics of resilience to drought in Ethiopia, Kenya and Somalia. USAID Centre for Resilience. reliefweb.int/sites/reliefweb.int/files/resources/Summary_Economics_of_Resilience_Final_Jan_4_2018_BRANDED.pdf

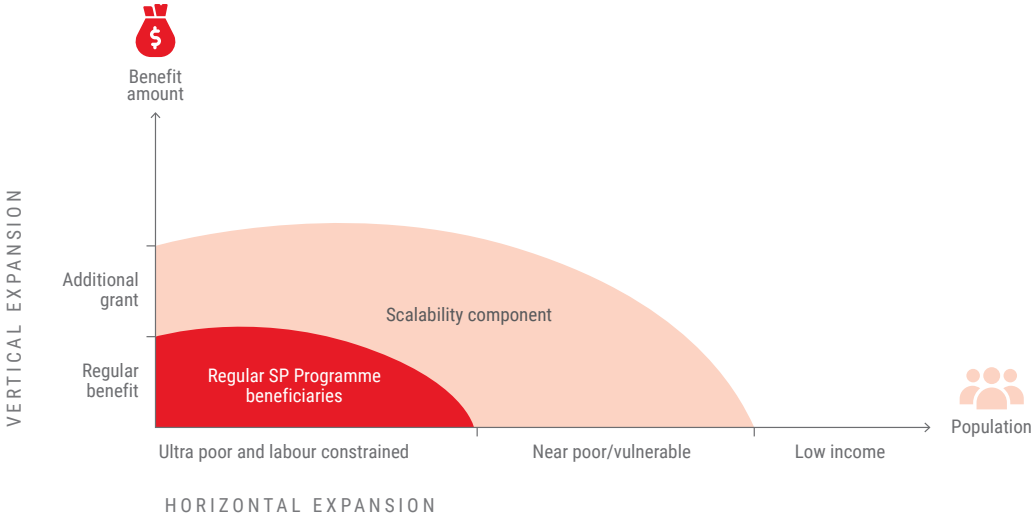
ability as a vehicle for early action, including forecast-based anticipatory action.[137]

For these reasons, social protection schemes have significant potential to help manage extreme-heat risks. This potential has only begun to be explored in a few countries. France, the UK and the US have all developed adaptive social protection schemes focused on extreme heat and extreme cold. In the UK, the system is anticipatory and forecast based, providing additional payments to offset heating costs in anticipation of cold snaps.[138] In Algeria, a national programme provides partial unemployment benefits to people unable to work due to extreme weather conditions, including heatwaves. More than 195,000 workers received these benefits in 2018.[139]

New and innovative financing mechanisms exist to support the expansion of social protection, providing options beyond traditional humanitarian funding that could support their adaptation to heat risks.

The Green Climate Fund has supported several countries to develop multi-hazard, impact-based early warning systems. In the Philippines, this included early action protocols for shock-responsive social protection.[140] In Africa, a number of countries participating in the Africa Risk Capacity (ARC) insurance mechanism included the

ADAPTIVE SOCIAL PROTECTION: HORIZONTAL AND VERTICAL EXPANSION



Source: Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [Masson-Delmotte, V., P. Zhai, A. Pirani, S. L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. World Bank. (2020). Climate Change 2021: The Physical Science Basis - Summary for Policymakers. Intergovernmental Panel on Climate Change. www.ipcc.ch/report/ar6/wg1/downloads/report/IPCC_AR6_WGI_SPM_final.pdf

137. Risk-informed Early Action Partnership secretariat. (2021). Early action and the climate crisis: could social protection be a game changer? www.early-action-reap.org/sites/default/files/2021-12/Early%20action%20and%20the%20climate%20crisis%20could%20social%20protection%20be%20a%20game%20changer%20FINAL.pdf

138. IFRC. (2021). Social protection for extreme temperatures: experiences from the UK, USA and France. socialprotection.org/fr/discover/publications/social-protection-extreme-temperatures-experiences-uk-usa-and-france-briefing

139. ILO. (2021). (rep.). World social protection report 2020-22: social protection at the crossroads - in pursuit of a better future. Geneva: International Labour Organization.

140. UK Aid, German Cooperation, GIZ, Australian Aid. Climate Centre. (2021). What are future financing options for shock responsive social protection? resiliencelinks.org/system/files/documents/2021-07/SPACE_Financing%20SRSP%20Summary%20Brief_0.pdf

scale-up of safety nets in their contingency plans. NGOs working with the World Food Programme and the START Network have been enabled in some contexts to purchase 'replica policies,' which release funding to support their operations on the same pre-agreed triggers as the ARC policy, allowing them to work side-by-side with Governments to manage these risks.

Whether and how these efforts could be extended to include extreme-heat risks, particularly in the most fragile contexts, remains an open question that needs further study and discussion. This process should not, of course, be restricted to extreme heat. In general, the broad range of climate risk is not yet sufficiently understood and integrated into social protection programme design.[141]

As investments are made to address this gap, it will be important to consider heatwaves as one potential shock that could partly be addressed by adaptive social protection measures. For example, extreme heat should be included, where relevant, in the development of multi-hazard warning systems linked to adaptive social protection schemes. And it will be important to adequately reflect the dimensions of vulnerability most relevant to heat risk, including gender, age and disability, in programme design.

Social protection can likely play an important role in protecting communities from the growing impact of future heatwaves. However, the limits of what they can be expected to deliver in the short term should also be recognized. Relatively few people in low-income countries are currently covered by social protection schemes – in sub-Saharan Africa only 18 per cent of people have access to even one benefit.[142] To make the necessary investments to expand and adapt existing systems to heat risks, Governments and their partners will rightly need to be convinced of the benefits – a business case that has not yet been adequately made.

Finally, social protection systems are often challenged to reach people working in the informal sector – a group at highest risk during heatwaves.

For these reasons, as social protection systems scale up and adapt to meet new climate challenges, there will be a continuing and critical role for community organizations and CSOs to work in a complementary way to reach the most vulnerable people. As with anticipatory action, close coordination under Government leadership will be key to ensuring this effort is as efficient and effective as possible.

Customs, traditions and techniques

Communities have thrived in even the hottest environments because of local expertise. Local knowledge, customs and techniques allow people – particularly indigenous people – to understand the seasonality of their environments, predict dangerous weather and take steps to protect themselves. Building practices, water storage techniques and land management strategies, such as controlled burning, are all examples of relevant coping mechanisms. This knowledge is often held in older generations and passed down orally. Traditional heat-management techniques were developed mostly in rural settings, but as urbanization has accelerated people have brought these techniques to cities.[143]

141. UK Aid, German Cooperation, GIZ, Australian Aid. Climate Centre. ITC University of Twente. (2021). Social protection and climate change: scaling up ambition. socialprotection.org/sites/default/files/publications_files/Paper%20-%20Social%20Protection%20and%20Climate%20Change_%20Scaling%20up%20Ambition%20%281%29%20%281%29_0.pdf

142. International Labour Organization 2021.

143. Codjoe, S.N.A., Owusu, G. & Burkett, V. Perception, experience, and indigenous knowledge of climate change and variability: the case of Accra, a sub-Saharan African city. Reg Environ Change 14, 369–383 (2014). doi.org/10.1007/s10113-013-0500-0

The new reality of heatwaves is dangerous because of ever higher temperatures but also because it disrupts the familiar patterns that these knowledge systems have evolved to manage. In India, for example, heatwaves that struck outside the familiar pre-monsoon season have proven significantly more deadly. Part of the reason the 2021 'heat dome' in Western Canada and the United States was so deadly – including for indigenous people – was that it fell so far outside of historical experience.

Even if climate change can challenge traditional knowledge and techniques, they nonetheless hold an important key to better management of heatwaves in the future, including by humanitarian actors. In northern Senegal, people living in traditional straw-and-wood shelters are far less exposed to extreme heat than those in more modern buildings.[144] In many parts of Asia, passive ventilation and cooling techniques used in traditional and indigenous shelters have been adapted to emergency response settings.[145] And the traditional North African technique of cooling with a clay zeer pot helps preserve food in hot conditions faced by conflict-affected people in Sudan.[146]

The critical role of indigenous and intergenerational knowledge underscores that

Families who escaped the conflict in Yemen now live in crude shelters that are exposed to the harsh elements and blistering desert sun.

Credit: OCHA/ Giles Clarke

144. orcid.org/0000-0002-3266-1001

145. www.sheltercluster.org/sites/default/files/docs/Indigenous%20Knowledge%20for%20Disaster%20Risk%20Reduction.pdf

146. Making a zeer pot fridge. Tearfund Learn. (2014). learn.tearfund.org/en/resources/footsteps/footsteps-91-100/footsteps-94/making-a-zeer-pot-fridge

heatwave responses are most successful as a locally rooted, 'bottom-up' endeavour. It also underscores the urgency of preserving this knowledge as the climate continues to change. As one member of the Plains Miwok people of California observed: "I truly know almost everybody who has a cultural knowledge of fire, and I could probably count them, including myself, on my two hands."[147]

Extreme heat and religious communities

Acts of religious observance, such as pilgrimage, outdoor prayers and festivals, can increase participants' exposure to climate hazards, including extreme heat. As with other areas of traditional knowledge, religious practices themselves often incorporate seasonal patterns and techniques that mitigate the impact of heat, such as bathing, and wearing light and loose clothing. But these traditions did not evolve to meet the challenges of new levels and unfamiliar patterns of extreme heat brought by climate change. It is therefore important that religious authorities and leaders consider the long-term changes and risks and are part of early warning systems and action plans for extreme-heat events and other hazards. In some contexts, humanitarian actors can play an important role in ensuring this information is shared and acted on.

But ensuring that learning and knowledge flow in the other direction is even more important. Some resources and experiences in religious communities are critical to successfully managing heatwaves now and in the future. Churches, temples and mosques have been used as cooling centres in many different contexts. Faith leaders often have detailed knowledge of the most vulnerable people – those who may be old, disabled or alone in their communities. This knowledge can be invaluable to help reduce mortality in a heatwave.

The Islamic observance of the hajj and umrah in Makkah is an excellent example of the risks and the potential for religious authorities to lead efforts to adapt and to protect people from extreme heat. The hajj involves spending roughly 20–30 hours outdoors over approximately five days. Because the hajj is aligned with a lunar calendar, which rotates through the Arabian seasons, it can occur during the very hot late summer and early autumn months. In the past, heat stress during these months has led to morbidity and mortality among pilgrims.[148]

Depending on reductions in emissions, climate models have shown that heat stress could reach extreme danger levels when the hajj next occurs during this season, from the early 2040s to the early 2050s.[149] One analysis projects a tenfold increase in heat stroke risk for the hajj and umrah at 2°C warming and a fivefold increase at 1.5°C.[150]

Saudi Arabian authorities have invested significantly in steps to prevent heat-related impacts for pilgrims, including by upgrading infrastructure and medical services, improving water availability, and leading education campaigns before and during the rituals.[151] The national Ministry of Health's National Hajj Extreme Heat Strategy brings these actions together and

147. Weil, E. (2022, January 3). This Isn't the California I Married: The honeymoon's over for its residents now that wildfires are almost constant. Has living in this natural wonderland lost its magic? The New York Times Magazine. www.nytimes.com/2022/01/03/magazine/california-widfires.html.

148. Saeed, F., Schleussner, C.-F., & Almazroui, M. (2021). From Paris to Makkah: Heat stress risks for Muslim pilgrims at 1.5°C and 2°C. Environmental Research Letters, 16(2). doi.org/10.1088/1748-9326/abd067

149. Kang, S., Pal, J. S., & Eltahir, E. A. B. (2019). Future heat stress during Muslim pilgrimage (Hajj) projected to exceed "Extreme danger" levels. Geophysical Research Letters, 46(16), 10094–10100. doi.org/10.1029/2019gl083686

150. Saeed, F., Schleussner, C.-F., & Almazroui, M. (2021). From Paris to Makkah: Heat stress risks for Muslim pilgrims at 1.5°C and 2°C. Environmental Research Letters, 16(2). doi.org/10.1088/1748-9326/abd067

151. Yezli, S., Mushi, A., Yassin, Y., Maashi, F., & Khan, A. (2019). Knowledge, attitude and practice of pilgrims regarding heat-related illnesses during the 2017 Hajj Mass Gathering. International Journal of Environmental Research and Public Health, 16(17). doi.org/10.3390/ijerph16173215

provides a platform for information sharing and decision-making.[152]

There are valuable lessons to be learned in managing heat risks surrounding the hajj that could be applied by Governments and humanitarian actors to other contexts. Returning pilgrims can play a role in applying approaches to extreme heat management learned during the hajj and umrah to their local contexts.

Partnerships between humanitarian actors and religious authorities to manage the risks of observance are not new. To take one example, NGOs have worked with the Orthodox Church to address the public health risks that come with pilgrimage in Ethiopia. Further developing these partnerships can pay huge dividends in ensuring that heat-management approaches are truly grounded in the experiences of the most affected communities, and in learning lessons from all relevant sources.

152. Kingdom of Saudi Arabia Ministry of Health. (n.d.) National hajj extreme heat strategy. www.moh.gov.sa/en/Hajj/PublicationsAwareness/Publications/Documents/National-Hajj-Extreme-Heat-Strategic-Strategy.pdf

Children in north-west Syria are especially at risk of severe heat stroke and dehydration, as they spend most of their time outside their plastic tents.

Credit: OCHA/Abdul Aziz Qitaz

PART THREE

FIVE STEPS TO HELP PREPARE FOR THE HEATWAVES OF THE FUTURE

The most important steps to prevent a future of deadly heat disasters lie at the 'upstream' end of the development/humanitarian continuum: urgent investments in mitigating and adapting to climate change. The more successful these investments are, the less loss and damage will be experienced, and the less emergency response capacity will be called on.

There is good news: The most effective interventions are well known and reasonably low cost. There is huge existing expertise in local actors and an impressive record of success to build on. The science is available, the tools are known, and the relevant partners are ready and willing to cooperate.

However, supporting local approaches to managing heat risks will require humanitarian planners to shift their thinking from a project orientation to a systems orientation. The more that humanitarians engage with extreme heat as a risk management problem, the less it will need to be dealt with as an emergency response problem. Wherever possible, extreme heat should be incorporated as an existing and growing risk into existing climate analyses, warning systems and multi-hazard contingency plans. Further segmenting the humanitarian sector and creating new and parallel workstreams should be avoided.

Humanitarians do not need to create a new system to deal with extreme heat, but they do need to think and act differently in at least five key areas.

1. **Build the evidence base on the impacts of extreme heat, and provide early, actionable information to decision makers.**
2. **Support preparedness and expand anticipatory action for heatwaves and compound disasters.**
3. **Explore new and more sustainable ways of financing local action.**
4. **Adapt humanitarian response to accelerating extreme heat.**
5. **Deepen engagement across the development, humanitarian and climate spheres.**

In Mabalane, Mozambique, many people dig holes to find water, but they often leave empty handed.
Credit: IFRC/Aurélie Marrier d'Unienville

During heatwaves, the Austrian Red Cross operates cooling centres that allow people to rest in an air-conditioned room.

Credit: Austrian Red Cross/Markus Hechenberger

1. BUILD THE EVIDENCE BASE ON THE IMPACTS OF EXTREME HEAT, AND PROVIDE EARLY, ACTIONABLE INFORMATION TO DECISION MAKERS

To meet the present and future challenges posed by extreme heat, the humanitarian system needs to be much more adept at bridging the gap between science and decision-making. This means bringing together meteorological, health and vulnerability information and making it available to the right people at the right time – particularly decision makers closest to the ground in a humanitarian response.

More research, more analysis

The lack of data on heat-related mortality and morbidity in developing countries masks the true scale and geographic spread of the problem. Improved data collection should be complemented by more focused research and analysis, including in priority areas such as the impact of African heatwaves, and extreme heat and gender. This is a system-wide challenge for the health sector, but steps could be taken in humanitarian settings to better record and understand heatwave-related mortality and

morbidity. Further analysis is also needed on current and future coping mechanisms being deployed in urban and rural communities to adapt and respond to heatwaves and heat stress.

Past events should also be analysed in more detail. Better understanding of health data will improve the development of context-specific triggers for early action. The Global Heat Health Information Network[153] is a critical platform for sharing information and analysis that deserves further expansion and support. Donors should require the projects they support to prioritize the open sharing of all relevant data across sectors.

Map the risks of humanitarian settings

Mapping areas of acute 'urban heat island' and of highest socioeconomic vulnerability – including in informal, off-grid settlements – has been a key step in enabling many cities to build effective heat action plans. Where humanitarians are already working in urban environments exposed to heatwaves, they should engage with local authorities to consider expanding this practice. Climatic maps of this kind do not need to be limited to heat; they can cover other hazards to provide a more complete picture of vulnerability and a more comprehensive response.

Effective mapping requires expanding temperature measurements to the places where the most vulnerable people live. Camp managers should also consider testing the practice of low-cost monitoring and heat-risk mapping in camp settings to better understand the nature of heat risk in their environments. The humanitarian sector has a wealth of mapping and geospatial expertise that could be extremely helpful in this effort.

Make forecasts accessible for all

Better models don't mean better outcomes. But they are indispensable for better decisions.

The emerging practice of impact-based forecasts could help humanitarian and development actors take a huge leap in anticipating not only extreme heat but other climate events. As in other areas, the task with forecasting is not to create a new and separate system for heat but rather to integrate and align within more comprehensive, multi-hazard systems. It is critical that operational actors work closely with scientific partners to ensure that forecasts are accessible to lay people and communicated in a way that the target audience understands.

The Alliance for Hydromet Development is establishing a plan to vastly improve hydromet services in developing countries.[154] And the UN Secretary-General has tasked WMO to lead an effort to ensure that every person on Earth is covered by an extreme-weather early warning system by 2027.[155] Delivering on these plans will be critical to enabling investments in resilience and early action.

Adapt existing tools

Humanitarian actors and information service providers should consider heatwaves in their analyses of risks and vulnerability. Within the IASC, the Index for Risk Management provides a critical tool for analysing risk. Heatwaves should be included as a

153. ghhin.org/

154. www.unep.org/resources/report/hydromet-gap-report-2021

155. public.wmo.int/en/media/press-release/%E2%80%8Bearly-warning-systems-must-protect-everyone-within-five-years

separate hazard in this and comparable tools, as well as the role of extreme heat in compound events including heat/drought.

Many other efforts are under way to synthesize climate risk analysis and make this available to decision makers in the UN system and beyond. These efforts include the United Nations Office for Disaster Risk Reduction's Global Risk Assessment Framework, Adelphi's climate security risk analysis and the inter-agency Climate Security Mechanism. These can be invaluable in helping Governments and their humanitarian and development partners to better understand their environments.

It is important that these efforts incorporate the most updated analyses possible of extreme-heat risks. In addition, it is important to consider resilience and systems thinking to address heat risks not only in humanitarian response but in longer-term programmes. For example, the Zurich Flood Resilience Alliance has adapted its Flood Resilience Measurement for Communities approach into a Climate Resilience Measurement for Communities that considers heatwaves as well as floods. Coping mechanisms need to be better understood in different contexts and for different vulnerable groups in the short and long term.

A volunteer from The Netherlands Red Cross visits older people to check if they need assistance during a heatwave in June 2020.

Credit: The Netherlands Red Cross

2. SUPPORT PREPAREDNESS AND EXPAND ANTICIPATORY ACTION FOR HEATWAVES AND COMPOUND DISASTERS

Heatwaves are perfect examples of the benefits of preparedness, ex ante financing and early action. Because they are highly seasonal and reliably forecastable in most places, much of what needs to be done to effectively reduce heatwave impacts can be planned and prepared for.

Multi-stakeholder planning and early action are shown to be effective in reducing mortality and morbidity in contexts both North and South. Local governments should own and lead such plans to the maximum extent possible, but humanitarian actors can help by participating in this planning where they are currently deployed at scale, and by supporting preparedness and planning in other contexts.

Expand and integrate Government-led plans

Despite the encouraging expansion of heat action plans worldwide, a huge amount remains to be done to expand this practice to low-income countries, including those with ongoing humanitarian operations.

Bilateral and multilateral development actors should be active in supporting Govern-

ments and municipalities to realize this, as should National Red Cross and Red Crescent Societies as auxiliaries to their authorities in the humanitarian field with experience in disaster and climate risk management. Even if they are not engaged in longer-term resilience efforts, other humanitarian actors have knowledge of vulnerabilities and experience in emergency response that can be usefully brought to bear in these planning processes.

One important consideration in this effort is legal. Formal recognition of heatwaves as disasters under national law can help to increase awareness, help unlock funding and enable important measures, such as protection for workers.

Prepare for heat risks

Supporting Government ownership of heat action plans is the most important long-term goal, but the humanitarian sector's internal preparedness planning needs to take greater account of the growing risks of extreme heat.

IASC partners should consider updates to the Emergency Response Preparedness approach to better incorporate heatwaves as a hazard and include relevant preparedness actions. Guidance on engaging Governments in emergency preparedness could also be expanded to include local and city governments, which are often the most relevant in heatwaves.

IFRC has been supporting Red Cross and Red Crescent National Societies to enhance their preparedness and readiness capacities for a timely and effective multi-hazard response.[156] These efforts should ensure that contingency planning integrates relevant heat scenarios and preparedness measures at the institutional and community levels. A culture of learning from previous heat-related emergencies should also be promoted and integrated into new programmes and operations. This includes enhancing learning on adaptation and coping mechanisms once heatwaves occur.

In general, the resources dedicated within the humanitarian system to disaster preparedness — especially in contexts where the IASC system is not deployed — are not commensurate with the risks brought by climate change. Support to international and local humanitarian actors to improve their engagement with Governments on disaster management planning should be significantly expanded.

Expand the anticipatory approach

The anticipatory approaches piloted in response to heatwaves are small in number and scale, but they show significant potential. Humanitarian actors that have engaged in these approaches (to date IFRC and START Network, together with local and international partners) should continue their expansion to different contexts and prioritize investments in learning and evaluation.

Where relevant, anticipatory action projects should aim to develop analyses and triggers that are attuned to compound disasters, especially those including heat and drought. Anticipatory approaches could also extend beyond their current focus on urban environments to include, for example, the impacts of extreme heat on agriculture and livestock in rural settings.

As anticipatory approaches grow in number, the challenge of coordination becomes all the more relevant. Sources of data and

156. www.ifrc.org/disaster-preparedness

forecasting and triggers and thresholds for action used by different actors do not need to be identical, but they should at the very least be coordinated and coherent. Ensuring coherence and alignment in this area is an important future challenge for the humanitarian coordination system that needs dedicated thinking and testing – now.

Synthesizing and integrating heat risks within existing workstreams, rather than creating new and parallel processes, should be the guiding principle. Stakeholders should leverage initiatives such as the Risk-informed Early Action Partnership and Anticipation Hubs to break the siloes to work across agencies, levels and thematic focus.

Anticipatory efforts within the humanitarian sector should be aligned under Government-led action plans where they exist.

Support community early warning

In addition to ensuring effective early action plans at the national level (by Governments and/or humanitarian partners), community early warning systems should be further supported – and connected to national early warning early action systems – to ensure that information and warnings reach and are actionable by the most vulnerable communities. National Red Cross and Red Crescent Societies and NGOs can play a key role in promoting the role of people-centred community early warning systems in reducing risk, including to heatwaves.

Plan for catastrophe

Supporting local systems should be the priority, but it should not preclude planning for high-impact events that could overwhelm national capacity. Given the expected increase in the frequency of currently very rare but very severe events, time should be invested now in considering what the international response to a heat catastrophe would look like, e.g. an extended blackout in a Southern megacity during a severe heatwave. Similarly, national disaster management plans should consider the tail-end risks of lower-probability and high-impact events, including what international support might be required. Simulation exercises that bring together both of these levels would be a valuable starting point.

Before drought hit Ethiopia's Afar Region in 2022, Mohammed Sabri and his extended family had more than 300 shoats. Only 20 survived.

Credit: OCHA/Liz Loh-Taylor

3. EXPLORE NEW AND MORE SUSTAINABLE WAYS OF FINANCING LOCAL ACTION

Even if heatwaves are not as resource intensive as other emergencies, preparation and response efforts will require their own sustainable financing. Just as heatwave response is most effective when locally led, any financing strategy must also focus on supporting action at the local level. In keeping with the need for synthesis rather than fragmentation, heat risks should be incorporated into broader climate and disaster-risk financing strategies that address a range of relevant hazards.

In some contexts, humanitarian financing can be incorporated as one component of such a strategy. Playing this role requires, first and foremost, meeting the localization challenge head-on. In 2020, less than five per cent of global humanitarian funding went directly to local and national responders, falling far short of the Grand Bargain's commitment to allocate 25 per cent of all humanitarian funding as directly as possible to national and local actors.[157] Accelerated efforts are needed to correct

157. Metcalfe-Hough, V., Fenton, W., Willitts-King, B., & Spencer, A. (2020). Grand Bargain Annual Independent Report 2020. cdn.odi.org/media/documents/Report__Grand_Bargain_annual_independent_report_2020.pdf Humanitarian Policy Group.

this imbalance in order to build a humanitarian system ready for the heatwaves of the future. Funding for local actors should be aimed at short-term interventions but also at strengthening their long-term response capacity.

Traditional international humanitarian financing mechanisms can complement and potentially underwrite other national and international funding streams, but in the long run they are neither appropriate nor sustainable as the primary means of supporting heatwave response. Heatwaves will be a frequent and predictable part of the future emergency landscape, and financing should ultimately be delivered through nationally owned and managed systems, notably in the health sector. Where humanitarian tools do play a role as a complementary or transitional source of financing, they can help promotoe action and demonstrate the types of interventions that benefit from longer-term investments.

Expand and explore new and existing funds

Two global pooled fund mechanisms have anticipatory action programmes in place for heatwaves in several countries: START Ready for NGOs, and IFRC's Forecast-based Action by the Disaster Response Emergency Fund for National Red Cross/Red Crescent Societies and their partners. Efforts to capture and share learning within and between these funds should be accelerated, with a view to further building the case for early action and demonstrating good practice. As the case strengthens, these approaches should be expanded, including to contexts where other emergency responses are under way. These funds deserve continuing support from donors, who should also explore anticipatory partnerships in their own bilateral funding.

The question of whether other pooled funding mechanisms – notably the Central Emergency Response Fund and the Country-Based Pooled Funds, operated by the United Nations Office for the Coordination of Humanitarian Affairs – should engage in early responses to heatwaves requires a bottom-up rather than a top-down answer.

As more humanitarian leaders in the field come to grips with the impacts of heatwaves and start to engage more with relevant partners, they should be encouraged to include extreme heat, where appropriate, in their risk and needs assessments as well as in their preparedness and readiness plans. The immediate priority should be supporting this process of local consideration and responding to requests for support that may arise, rather than a supply-driven approach that presents extreme heat as a priority to be responded to. The financing discussion can then move forward in contexts where there is an interest to do so.

Examine the potential of risk-transfer mechanisms

The financing strategies that accompany heat action plans can include a mix of ex ante and ex post funding streams that are suited to the circumstances and the actors involved – including humanitarian actors. In some contexts, risk-transfer mechanisms, including insurance products and instruments such as impact or catastrophe bonds, could form one part of that mix. A limited number of private businesses have taken out parametric insurance products, which provide payouts when a defined threshold is reached rather than against actual damages. These businesses include utilities, agricultural interests and con-

struction firms seeking to mitigate the risk of lost income due to extreme heat.[158]

However, reaching the poorest and most vulnerable people with insurance products has proven to be a huge challenge, and in some cases they can risk exacerbating inequality.[159] Whether and how insurance products can be usefully extended to public health and other human impacts of extreme heat requires answers to a number of questions: Who would be the customer for the insurance product? How are discrete, insurable events to be defined? Is monitoring and data collection (particularly in lower-income settings) sufficient to make such a product viable?

To explore these questions, humanitarian and development actors could engage with the insurance industry through existing platforms, such as the Insurance Development Forum. Risk-transfer products would likely be limited to the most severe tail-end risks of the most extreme events, with other national and international financing solutions addressing more frequent and less severe episodes.

Partnerships to protect the vulnerable

Expanding the reach of adaptive social protection schemes and ensuring they cover the most vulnerable people is one of the most critical opportunities in building resilience to climate change. Humanitarian actors should work with relevant Government and development partners to explore the opportunities to include extreme-heat risks in adaptive social protection schemes. This should include incorporating extreme heat among the hazards featured in early warning systems, ensuring that the dimensions of vulnerability most relevant to extreme heat are covered in targeting criteria, and finding ways to reach people working in the informal sector.

Piloting the incorporation of extreme heat into adaptive social protection in one or two jurisdictions – or focused on a particularly vulnerable group such as elderly people or pregnant and breastfeeding women – could generate learning and test the boundaries of a broader business case. Innovative funding partnerships should also be explored – including the use of insurance products or more straightforward humanitarian funding streams – to support the additional costs associated with expanding social protection during a heatwave.

158. Lamm, T., Blumberg, L., & Elkind, E. (2020). (rep.). Insuring Extreme Heat Risks: scoping the potential for insurance innovation to support heat mitigation and response. www.law.berkeley.edu/wp-content/uploads/2020/11/Insuring-Extreme-Heat-Risks-Dec-2020.pdf

159. See for example Oxfam (2019): Facing Risk: Options and challenges in ensuring that climate/disaster risk finance and insurance deliver for poor people. oxfamilibrary.openrepository.com/bitstream/handle/10546/620457/bp-facing-risk-climate-disaster-insurance-160418-en.pdf;jsessionid=BA333530785EDA2AEC25F11DC03193FA?sequence=13

In a camp for conflict-displaced people in north-west Syria, children cool down from soaring summer temperatures in a makeshift pool in the back of a truck.

Credit: OCHA/Ali Haj Suleiman

4. ADAPT HUMANITARIAN RESPONSE TO ACCELERATING EXTREME HEAT

Adapting to the new normal

Adapting humanitarian programming to include extreme heat will be a long-term effort requiring significant investments in research and learning. In many relevant sectors, important steps have already been taken in this regard. In shelter, agencies are testing the viability of more thermally appropriate emergency housing, and piloting 'green roofs' and other adaptations aimed at cooling.[160] In the health sector, WHO has generated a wealth of guidance on responding to the health risks of extreme heat. In education, UNICEF has worked with educational authorities to adjust school timetables and provide additional water during periods of extreme heat. And IFRC is developing new guidance on managing cooling centres.

These and other efforts should be accelerated in each relevant sector to ensure that interventions reflect the new normal of accelerating extreme-heat risks, including by revisiting Sphere Standards, where appropriate. Standards should, of course, be

160. See for example: Castro, Kuchai et. al. (2021). ShelTherm: An aid-centric model for shelter design. Journal of Building Engineering, 44, 102579. doi.org/10.1016/j.jobe.2021.102579

attuned to the particular needs of vulnerabilities related to gender, age, disability and occupation. And wherever possible, including, for example, in the water, sanitation and hygiene (WASH) sector, the development of humanitarian standards should go hand-in-hand with broader resource management strategies aimed at addressing the chronic challenges presented by extreme heat.

Protect people in camp environments

Camps share many of the characteristics of informal urban settlements that make them places of extremely high risk during heatwaves. Humanitarian actors involved in camp management and response should take further steps to adapt the techniques that have successfully reduced mortality in urban environments and use them in camp settings.

Including camp managers in early warning systems, launching public health communication campaigns and developing site-specific action plans for high-impact heatwaves are all viable options that should be tested. The mobile cooling centres deployed in cities such as Hanoi[161] could be considered for certain camp facilities, including clinics and dedicated spaces for the elderly. While large expansions of energy-intensive air conditioning should not be considered an option, efforts should nonetheless be accelerated to ensure access to sustainable energy in camp environments to support interventions such as misting and cooling fans.

Setting aggressive, sector-wide targets and action plans to expand renewable energy in camp environments would bring major benefits beyond those related to extreme heat, and they should be a critical element in the follow-up to the Climate and Environment Charter for Humanitarian Organizations.[162] The Clean Energy Challenge set by the United Nations High Commissioner for Refugees is an encouraging step in this direction.[163]

Engage in 'summerization' plans

Humanitarians must prepare not only for the acute risks that will come with more frequent and severe heatwaves but also for the predictable, seasonal risks that will deepen as temperatures creep higher. Just as winterization is now a regular component of humanitarian programming, humanitarian agencies and country teams should consider 'summerization' (or 'heat season') plans in regular contexts.

Summerization plans can include measures such as activating heightened monitoring and early warning, ensuring thermally appropriate shelter, establishing cooling centres and ramping up public health communication efforts. Heat season plans are particularly important in contexts where seasonal forecasts (which themselves need to become a much more familiar and widely used tool in the humanitarian planning cycle) indicate a heightened risk of extreme-heat events. They should be embedded in the humanitarian programme cycle where relevant, and season-specific plans should be developed far enough in advance to realize all the benefits of early action.

Humanitarian and development actors can learn from the experience in some settings of winterization and summerization (e.g. Iraq and Syria) and from seasonal planning in some high-risk countries (e.g. Qatar).

161. See Climate Centre, German Red Cross. (2019). Forecast-based financing: Vietnam. www.forecast-based-financing.org/wp-content/uploads/2020/04/Factsheet_Vietnam.pdf

162. www.climate-charter.org/

163. www.unhcr.org/en-us/clean-energy-challenge.html

Cash creates choice

In limited contexts, feedback has been collected from people who benefited from humanitarian assistance during heatwaves and other settings. That feedback indicates a strong preference for cash assistance.

Cash can increase the choices available to the most affected people during a heatwave. For example, it allows workers in the informal sector to take breaks or days off, and it gives elderly people a means of paying for electricity. Even when cash programmes are initiated for reasons other than extreme heat, they have the flexibility to provide this type of support during a heatwave when they are unrestricted.

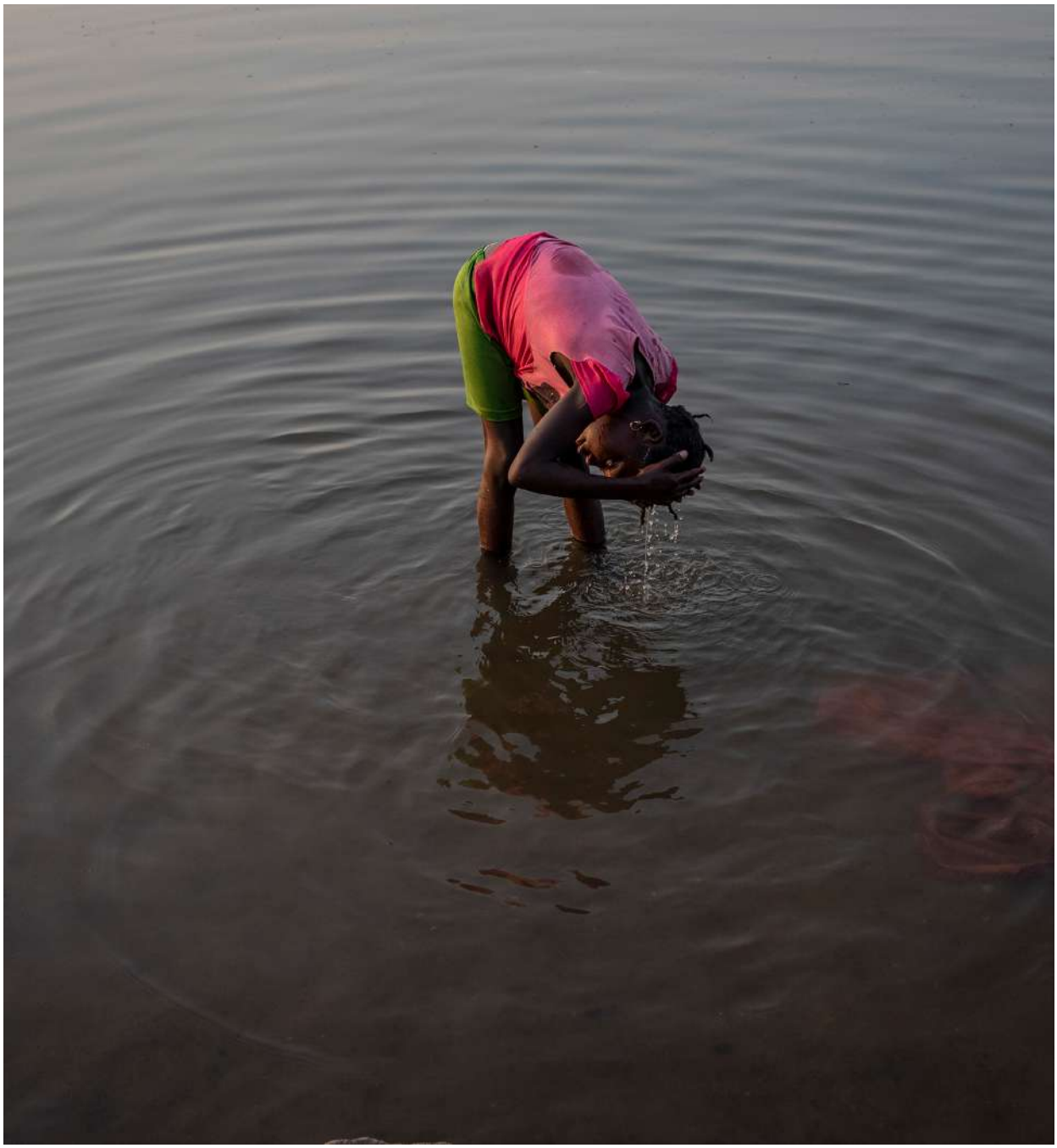
In some contexts, humanitarian programming options involving other types of transactions can also be explored, such as waivers for utility payments during heatwaves. Humanitarian operations that involve cash-for-work projects should be suspended or adapted to heat stress during heatwaves, in line with ILO guidelines.

Update tools for heat

Few coordinated humanitarian needs assessments incorporate extreme-heat risks or anticipate the potential impact of heatwaves on people receiving humanitarian assistance.

The Global Humanitarian Overview, produced by the Inter-Agency Standing Committee (IASC), refers to heatwaves as a growing threat, but it does not include any specifically targeted actions. IASC partners should review coordinated assessment tools and data platforms to ensure that extreme-heat risks are incorporated where relevant. Where severity indices are being developed – for example in the WASH sector – these should be reviewed to ensure they adequately address the specific risks presented by heat.

Efforts to update assessment tools should include exposure to the hazard but also the specific dimensions of vulnerability, including age, gender, occupation, pre-existing health conditions and disability. They should equally consider the compounded impacts of heat and other hazards – especially drought – where they occur simultaneously. The development of a consolidated assessment tool for measuring the heat risks most relevant to a given context should also be explored, building on the vulnerability analysis and scoping tools that have been used in cities and in the limited humanitarian contexts where heatwave responses have been tested.



In Bangui, CAR, most people live well below the poverty line as the country is traumatized by years of unrest.

Credit: OCHA/ Siegfried Modola

5. DEEPEN ENGAGEMENT ACROSS THE HUMANITARIAN, DEVELOPMENT AND CLIMATE SPHERES

Partners and enablers

A sustainable approach to extreme-heat risks will require massive and targeted investments across a broad continuum that encompasses urban planning, resilient infrastructure, social protection, workers' rights, climate adaptations and much else besides. Early warning and emergency re-

sponse should be understood as occupying only one end of that continuum.

Humanitarian actors' direct interventions may be focused at this 'emergency end,' but they can and should play a role as advocate, partner and enabler across the entire range of action. Where a Government's national development and adaptation plans are not fully attuned to heat risks – which is the case in many low-income countries – humanitarians can help make available data and analyses that demonstrate the startling scale of present and future impacts.

By engaging, wherever feasible, in development planning efforts, such as the United Nations common country analysis and cooperation frameworks, humanitarians can help ensure that these efforts focus on the most vulnerable, and that development programmes are appropriately layered and sequenced with emergency response towards common objectives. National Red Cross and Red Crescent Societies can also play a unique role in influencing and supporting their Governments, given their permanent presence and auxiliary role to their authorities. Deeper partnerships with academic and research institutions focused on extreme heat and other climate risks can help humanitarians play all the above roles.

Urban environments, city governments

Urban humanitarianism has received increasing attention in recent years,[164] and the expansion of thinking and training in this area is to be welcomed and encouraged. For humanitarians to manage the risks of climate change, including extreme heat, they will need to understand and work more comfortably in urban environments.

City governments have been on the front lines of thinking and action in heatwave response. They are increasingly working together and learning from one another through initiatives such as C40 Cities, the Global Covenant of Mayors for Climate and Energy, and the Extreme Heat Resilience Alliance. Humanitarians can help these efforts succeed by sharing data and exploring complementary programmes where there are gaps. National Red Cross and Red Crescent Society local branches can and should lead and support their municipalities in preparing for and responding to heatwaves in towns and cities. Engaging with these networks to find the most useful entry points is a good place to start. Humanitarian actors in relevant contexts should also consider initiating joint planning with city governments preparing for extreme heat in current urban or peri-urban humanitarian operations.

Science, data and expertise

To face a hotter future, humanitarian actors need to invest in partnerships aimed at improving the way that climate information and analysis are generated, distributed and acted upon. Collaborations that bring together climate science, data analysis and humanitarian expertise will be critical to bringing actionable information to the right place at the right time.

If humanitarian actors are to expand their planning horizons and take in the full range of emerging risks, including extreme heat, they need reliable, understandable and actionable projections of climate impacts. To produce this type of tailored product for the country level, the IASC should explore ways to expand and deepen relationships

164. See for example: Archer, D. (2017, November 16). The future of humanitarian crises is urban: It's time to Urbanise Crisis response. IIED research has identified three approaches to improve effectiveness. International Institute for Environment and Development. www.iied.org/future-humanitarian-crises-urban

with WMO and other climate-science organizations. Within the UN system, these efforts should be closely aligned with the development coordination system to maximize synergies and avoid duplication or parallel information streams.

Partnerships with climate science will also be critical for advocacy, as they can help produce analyses of future humanitarian impacts to inform processes such as negotiations at the UN Climate Change Conference. The Red Cross Red Crescent Climate Centre should also be further supported to share scientific knowledge about climate change impacts and help make it operable at the local level.

Engage with religious authorities

Religious communities have a wealth of knowledge and experience in managing extreme heat that can be indispensable to humanitarian actors. Where it makes sense in the local context, humanitarians should consult with religious leaders on how facilities can be used to protect people in heatwaves and how information on vulnerability can be shared.

Relevant authorities' experience of extreme-heat management during the hajj is a particularly relevant case that should be the subject of increased engagement and learning.

Private sector, public knowledge

Private sector actors play a massive role in managing heat risks faced by workers, and they can be critical partners in managing the broader impact of heatwaves. Companies around the world have worked with humanitarians to help communicate public health information, make facilities available as cooling centres, and provide relevant goods and services in high-risk settings, such as informal settlements and camps.

If interventions such as suspending utility payments or protecting critical infrastructure during heatwaves are to be expanded, engaging with the private sector will be critical. Major private projects, including ports and mines, can have access to specialist climate analysis services that could be more systematically shared with local communities and humanitarian and development actors in data-poor environments. Economic analyses that show massive losses in labour productivity and slowed economic growth due to extreme heat should give companies ample incentive to act.[165]

Support leadership, engage locals

Humanitarian leaders can often feel on the receiving end of an ever-longer list of priorities and expectations – few of which come with additional resources. This partly explains the importance of incorporating extreme heat as much as possible into existing risk-management systems and processes, rather than creating new and separate workstreams. Efforts must also be concentrated in places where the threat is highest and the prospect of making a difference is real.

To inform development investments and emergency response planning, Humanitarian Country Teams (HCTs) and UN Country Teams should be provided with data and analysis to help them understand extreme-heat risks. HCTs should also, of course, continue expanding the practice of including local actors, who often have the

165. Chavaillaz, Y., Roy, P., Partanen, A.-I., Da Silva, L., Bresson, É., Mengis, N., Chaumont, D., & Matthews, H. D. (2019). Exposure to excessive heat and impacts on labour productivity linked to cumulative CO2 emissions. Scientific Reports, 9(1). doi.org/10.1038/s41598-019-50047-w

most relevant perspectives on the impact of heatwaves.

At the individual leadership level, guidance and training for Resident and Humanitarian Coordinators should be revised to ensure it adequately reflects the growing threat of extreme heat along with other climate hazards. Humanitarian leaders that take on a more prominent role in this area need to be supported, most importantly by people with the skills and experience to help them succeed.

As experience grows in the sector, IASC partners should explore options for pooling expertise on heatwave preparedness and response and establishing a deployable advisory capacity to provide support, where necessary.

An unusual heatwave in Syria triggered wildfires that affected more than 20,000 families and partially or fully burned more than 140 villages.

Credit: Syrian Arab Red Crescent

PART FOUR

CONCLUSION

A DIFFERENT TYPE OF DISASTER, A DIFFERENT TYPE OF RESPONSE

To adapt the international humanitarian system to the present and future risk of heatwaves, it is critical to understand how heatwaves are similar to and different from the emergencies that have shaped the humanitarian system. Understanding this will allow humanitarians to think differently and, ultimately, act differently.

The impacts of heatwaves are dreadfully familiar to humanitarians. They can overwhelm hospitals, leave people desperate for clean water and reduce families to one meal a day. But while heatwaves can be every bit as deadly as other emergencies, they have a spatial and social footprint that sets them apart.

There is a unique geography to a heat emergency that can confound traditional ways of thinking in the humanitarian sector. City maps that record deaths in a heatwave reveal a familiar pattern: concentrated, to be sure, in poor and marginalized areas. But within those areas, the victims are dispersed. Rather than the focused devastation of an attack on a marketplace or the landfall of a typhoon, the impact is scattered. Instead of a hundred people on one block, a heatwave kills a few people on each block. A hundred people suffering together but disconnected.

In this sense, heatwaves also have a unique sociology. They are the loneliest disaster.

A woman cools down in Pakistan, where authorities issued heatwave warnings as daytime temperatures hovered between 40-44°C/104-111°F.

Credit: AFP/ Rizwan Tabassum

Their first victims are often the socially and physically isolated. In a manner similar to COVID-19, heatwaves expose and prey on the inequalities in a community. Even when the risks of extreme heat are understood, construction workers, farmers and homemakers have no choice but to expose themselves to that heat. And even if cooling options are effective and available, many people lack the resources to access them. In a heatwave, the economically insecure are pushed to the front lines. The first to die at home are the elderly, the lonely and the sick.

Preventing and responding to heatwaves requires detailed knowledge of who, and where, those people are. But that knowledge can only be local. This reality challenges the familiar model of humanitarian action that is based on rushing external assistance to a disaster. Preventing a future full of deadly heatwaves should not be a matter of standing up complex logistics chains, managing camps or shipping food from across the world. It should be a matter of supporting communities and local organizations to protect their most vulnerable.

Heatwaves demand a response that is embedded in the affected community. The critical actors are municipal governments, local organizations, religious groups and local health professionals. Their work cannot be substituted by international aid workers, but it can be informed and enabled through supportive international engagement. A humanitarian system fit to confront a future of ever more dangerous heatwaves – and arguably the climate crisis in general – is one that is focused on providing that type of engagement.

The good news is that the humanitarian sector already has the principles and the key elements of an agenda to achieve this. Many of the changes necessary to build such a system are the ones that humanitarians have already agreed to pursue through the Grand Bargain, the Climate and Environment Charter for Humanitarian Organizations and other commitments: more links with science and development partners, better use of data and analysis, scaling up cash, localization, early action, and flexible and adaptive financing.

Heatwaves are a test of humanitarians' commitment to the long-held principle that all suffering should be addressed, and to the more recent goals that the sector has set for itself. Preparing for a hotter future does not require a radically new humanitarian agenda. It does require that these goals are pursued with a new urgency.

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