ISSUE BRIEF

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HEATWAVE

A string of deadly heatwaves has impacted millions around the world in 2019. This issue brief examines the cause and the implications of heatwave for our path towards sustainability.

In the news

A string of deadly heatwaves has impacted millions around the world in 2019. Beginning early in the year with extreme heat episodes in Australia and the Middle East, by early May temperatures then soared to 51°C in northern India and Pakistan, and in June temperatures exceeded 45°C in some parts of Western Europe. By the end of June, the heatwave in India became one of the longest ever recorded and killed hundreds of people. Its impacts were compounded by water shortages, leading to riots, violence and major migrations out from rural areas. In Spain, the 2019 heatwave has sparked the worst wildfires in 20 years forcing evacuations and drawing on military emergency personnel. These events occurred unseasonably early and are longer and hotter than previous heatwaves.

Why is this happening?

As climate change intensifies, disruptions to traditional global atmospheric circulation systems, such as the jet stream in the northern hemisphere, are expected across the planet, leading to more frequent and intense extreme climate events. In particular, smaller differences in temperature between the poles and the equator can slow the jet stream, leading to a buildup of high or low pressure weather systems, resulting in more persistent hot-dry extremes in mid-latitudes.[1] The current heat wave in Europe is linked to a slow-moving system in the North Atlantic that allowed hot air from the Sahara to move north.[2] In Pakistan and northern India, the heatwave lasted longer than usual due to a delayed start to the seasonal monsoon. This may become more common in the future as a shifting seasonality of the monsoon is expected with climate change.[3]

Why does this matter?

We live in a warming world. As average global temperatures rise, so too does the probability of more extreme hot temperature anomalies, resulting in earlier, longer and more frequent heatwaves.[4] [5] Heatwaves now pose a recurring challenge on all inhabited continents and generate an increasing range of threats to human lives and well-being,[6] particularly in cities where built environments magnify heat exposure.[7] This matters because close to 70% of the world's population is expected to live in cities by 2050 and will be exposed to extreme heat.[8]

What are the implications for our path towards sustainability?

Heatwaves have multiple cascading social, ecological and economic implications in the immediate and long term. Below we explore some of the ways that heatwaves can negatively impact our world. We then describe effective measures to respond to and mitigate the impacts of extreme heat, helping us move towards a more sustainable social and environmental future.

- **SOCIAL IMPACTS:** Extreme heat can lead to heat-related illness and death, particularly in elderly populations, the poor, outdoor workers, and in urban areas. For example, during the 2003 European heatwaves an estimated 70,000 additional people died due to the heatwaves,[9] and in the United Kingdom alone, the impact of this heat wave was estimated at £41M in health-related costs and productivity.[10] Heatwaves exacerbate the urban heat island effects, amplifying temperatures in built environments, and resulting in poorer air quality due to the creation of ozone that negatively impacts health.[11] Heat-related mortality is expected to be higher in cities, particularly those characterized by high population density, inequalities, limited access to health care, high pollution levels and fewer green spaces.[12]

  Moreover, heat-related social impacts are not evenly distributed across populations. Wealthier people have greater opportunities, compared to poor populations, to access water, cool environments, air conditioning and/or relocate, thereby exacerbating social and economic inequalities. Poor neighbourhoods and informal settlements, such as slums that today house more than 800 million people globally,[13] are more often exposed to environmental risks like heat, due to poor infrastructure, building design and disadvantaged locations.[14] [15] Droughts increasingly accompany heatwaves [16] [17] [18] and can lead to violence over scarce resources.[19]

- **ECONOMIC IMPACTS:** Multiple areas of the economic sector experience reduced worker productivity during heatwaves, especially agriculture and construction. Globally, 2% of total working hours is projected to be lost every year, either because it is too hot to work or because workers have to work at a slower pace. Lost productivity from heat stress at work, particularly in developing countries, is expected to be valued at $4.2 trillion dollars per year by 2030, driving more inequality.[20] The agricultural sector, where 940 million people earn their livelihood, is set to be harder hit by hotter temperatures, pushing workers, crops and livestock past their physiological heat and drought tolerances.[21] [22] This will result in lost labour, in smaller harvests for farmers, higher prices for consumers, and negative impacts on livelihoods. For example, during the 2012 heatwave in the United States, maize yields dropped by 13%, resulting in a sharp increase in global corn prices because the United States supplies 40% of global production. In the short term, such weather events resulting in food price volatility put low-income countries, and those with high crop import dependency ratios, at risk of food insecurity.[23]

  In parts of India, changes to weather patterns and the resulting impacts on agriculture and other sectors are expected to translate into a 9% decrease in standards of living by 2050 assuming no adaption.[24] A World Bank report suggests that by 2050, about 600 million Indians will live in places that could experience loss of living standards, which could cost 2.8% of the GDP, stalling efforts to pull large parts of the population out of poverty.[25]

  Increasing energy demand for cooling also comes as an extensive economic cost to residents, businesses, and governments. Often energy grids are unable to supply the required power for air conditioning in cities during heatwaves.[26] [27] This results in not only increased emissions from carbon-based energy sources, but the failure of power grids, loss of power to businesses, hospitals, and critical infrastructure – compounding loss of productivity, increased costs for the energy sector, and reduced access to life-saving cooling and medical care. New power infrastructure is needed to support this demand in some areas and new lower-emission lower-heating technologies are critical. With these extreme heat events, the need for access to cooling should be viewed as a basic necessity – not just for health and productivity reasons but, in some cases, even for survival.[28]

- **ECOLOGICAL IMPACTS:** Heatwaves, without concomitant increases in precipitation, can lead to water shortages and increased stress for plants, particularly in arid regions.[29] This has the effect of reducing plant growth, the basis of energy production and the food chain, with an overall drying-out of the landscape. In Europe, the 2003 heatwaves caused tree damage, increased leaf fall and turned carbon-sink landscapes into carbon-sources, releasing more CO_2 into the atmosphere than was absorbed.[30] These hot and dry conditions are favourable to the start and rapid spread of forest fires, which now regularly accompany heatwaves. In 2010, during the heatwave in Russia – which was the hottest in 130 years – more than 15 million hectares of forest, vegetation and peat land areas burnt, and importantly in areas without fire-tolerant species.[31] Heatwaves can also dry up shallow aquatic ecosystems and accelerate glacier melt. For example, the 2003 European heatwave resulted in a 10% loss in glacier mass in Europe, which was five-times more than the average annual loss.[27] Similar impacts were reported for the French Alps in 2019. Over time, such deep permafrost warming and thawing could cause landslides and rock falls, continuing the negative ecological impacts.[27]

Heatwaves and health: a new opportunity for innovation & research

As the effects of heatwaves become more frequent and visible, funding and research targeting heat and health is a high global priority. For example, the September 2019 UN Climate Action Summit coalition on social and political drivers is advocating for key actions that cities and governments can invest in like heat protection. It is also encouraging development banks, philanthropy, and private sector to commit funds for climate-informed health surveillance and response systems for heatwaves. Similarly, the Belmont Forum has prioritized heat and health as one of three themes for the 2019 funding call on Climate, Environment, and Health where €11M in cash and in-kind resources is committed to support up to 12 research projects. The European Commission's Horizon 2020 has committed around 35% of the €80B research fund for climate-related expenditure, including health research to better understand current and future heat risks for the EU.

On the research and application front, the World Climate Research Programme studies global climate systems evolution to inform societal understanding of risks. The World Weather Research Programme advances society's ability to cope with high impact weather by focusing on improving the accuracy, lead time and utilization of weather prediction. The Global Heat Health Information Network is a group of scientists, professionals and policy-makers working to enhance research to action and promote science-based decision tools to better manage heat risks. Regular events and an online learning center provide resources on heat health including case studies of heat management tools and models already in practice. The Climate Services for Resilience Development is a large public-private initiative that focuses on heat (and other) risks, by developing new guidance and online decision tools.

And at Future Earth, heat is a cross-cutting theme across the work of our Health, Urban, and Risk Knowledge-Action Networks, that seek to generate multi-faceted knowledge to inform solutions for complex societal issues.

Pathways forward to sustainability

The most effective way to avoid the negative impacts of heatwaves is to mitigate climate change by reducing greenhouse gas emissions (GHG) and minimize the rise in global mean temperatures. In particular, shifts towards cleaner energies will not only reduce GHG emissions, but will also reduce localized air pollution and heat island effects within cities.[11] [12] Secondly, new initiatives to create early warning and response systems[32] and improved communication approaches[33] can help to save lives and build resilience to heatwaves. Thirdly during a heatwave, decision-makers can employ a range of strategies and policies to modify social behaviour and reduce exposure to heat by closing schools or offices which lack adequate air conditioning, ensuring availability of water, health care and first aid, and extending access to pools, parks and public cooling centers.[34] Finally, improved urban design and sustainable planning that increases the amount of and access to green space and other cool environments (pools, air-conditioned spaces) and encourages white roofs, will play an important role in avoiding heat-related illness, in reducing surface temperatures, and in providing a wealth of other nature-related benefits.[35] [36] [37]

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