CLIMATE AND HEALTH

Climate attribution of heat mortality

Mortality associated with rising temperatures is one of the clearest and impactful fingerprints of a changing climate. Research now shows an attributable increase in mortality due to climate change is already evident in cities on every continent.

Dann Mitchell

Increased air pollution, wildfires, agricultural stresses and direct physiological failures — these are just some of the consequences of a heatwave that impact health. In the most extreme cases, single heatwaves have taken tens of thousands of lives, with orders of magnitude more people requiring medical treatment and hospitalization[1]. But these heatwaves are changing with human-induced climate change, and even in 2003 significant increases in the likelihood of heatwaves were evident[2]. The nature of the heat–health problem is more complex than that of heat alone. It varies dramatically from country to country, and even city to city within a country, with the interplay between meteorological and socioeconomic factors making the problem far from trivial to dissect. For instance, inadequate infrastructure for psychiatric patients and prisoners in Egypt mean they are often disproportionately affected by heat, or using loft conversions (the hottest part of the house) for bedrooms in the UK's aging houses hinders people's ability to cool during the night-time. Each country has its own combination of factors that feed into its heat–health burden, and modelling this requires details specific to each city. It is therefore a momentous task undertaken by Ana Vicedo-Cabrera and colleagues[3], whose study in this issue of *Nature Climate Change* advances understanding of the heat–health burden due to climate change of over 700 different locations around the world, spanning 43 different countries.

Understanding how climate change has made, and will make, the heat–health problem worse is critical, but multi-continent studies of the relationship between heat and mortality have only really been developed in the last decade[4]. Such studies require sophisticated statistical methods combined with daily mortality observations for individual cities or provinces, and many countries lack these data. Indeed, for many lower- and middle-income countries, these data do not appear to exist at all, and certainly not in accessible formats. Therefore, a truly global heat–health analysis is not yet possible, at least not without significant assumptions

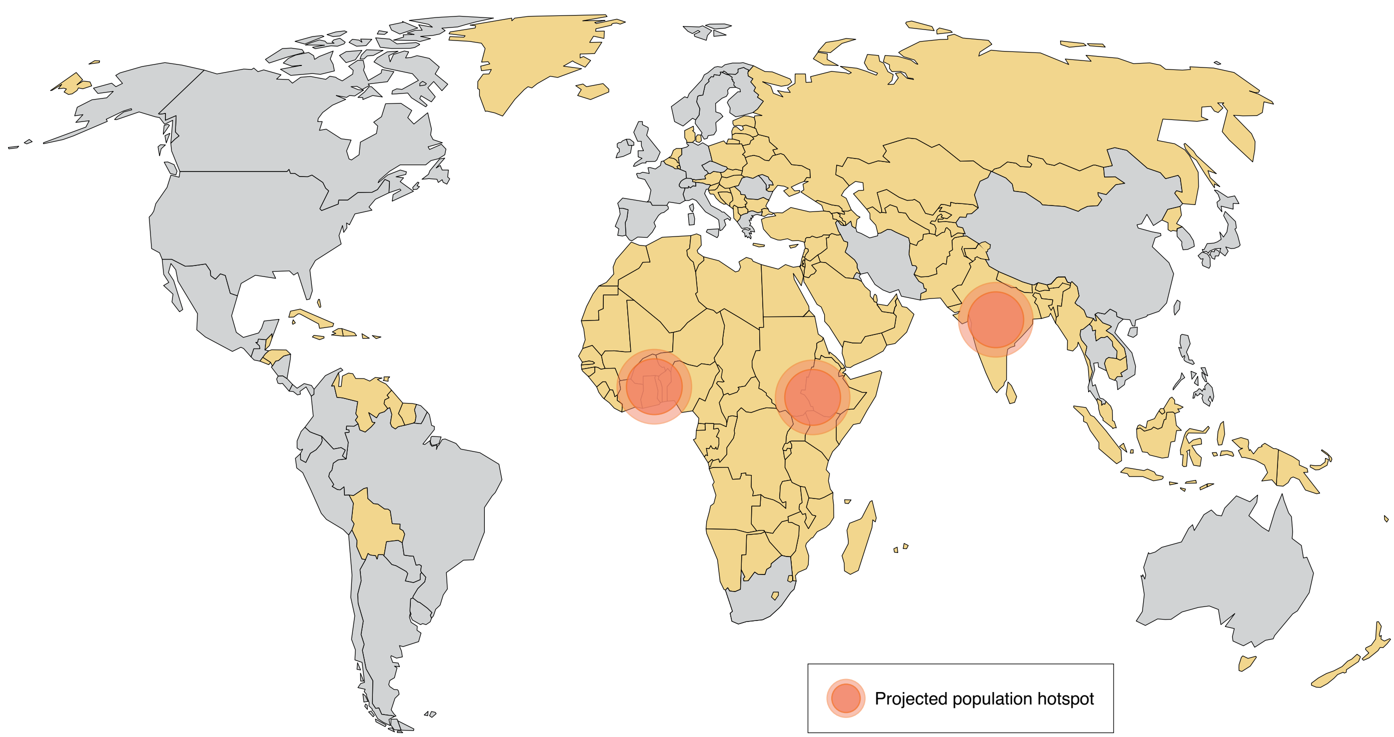

Fig. 1 | Global map of missing mortality data and projected population hotspots. Countries where daily mortality data could not be obtained by Vicedo-Cabrera et al.[3] include most of Africa and the tropics (yellow regions). Grey regions show where data were obtained. Red circles show the three largest hotspots for projected future population increases over the next 50 years, which all coincide with locations where no daily mortality data exists.

regarding the burden in remote regions of the world. The countries where we do not have the necessary health data are often among the poorest and most susceptible to climate change, and, concerningly, are also the projected major hotspots of future population growth (Fig. 1). Obtaining these data will be key for science to provide the information needed to help these countries adapt.

Using the largest collection of heat mortality data to date, with detailed coverage over North America, South America and Europe, Vicedo-Cabrera et al.[3] showed that heat-related deaths increased exponentially for the most extreme temperatures in the hot season. The most extreme health response to temperatures were seen in southern and central Europe, although notable impacts were also observed in individual countries around the world. The real danger, however, occurs when these heat-mortality-sensitive countries coincide with rapid temperature increases from climate change, and Paraguay and North Vietnam were highlighted as acute examples of where this has already happened. In these countries, total mortality — that is, mortality from any cause — was modelled to have increased by up to 5% since preindustrial times due solely to more heat-related deaths from climate change, although uncertainties in these numbers are large. On the lower end, modelling of countries in eastern Asia or northern Europe showed, on average, a 1% increase in total mortality due to increased heat-related impacts from climate change, although in many cases this signal was not considered significant above the background noise.

The detection and attribution of the impact of weather (for example, mortality), rather than the weather itself (for example, temperature), is an emerging field in the climate sciences, with only a handful of studies having considered this problem[5,6]. This shift in thinking is essential as scientists focus more on how societies and ecosystems have been, and will be, impacted by climate change so that global leaders can understand the risks and manage them through adaptive measures.

While Vicedo-Cabrera et al.[3] focussed on the attribution of heat-related mortality to past climate change, there has also been a shift to look at this problem in terms of future climate change projections[7]. However, few of these studies focus on extreme events, opting instead to understand the continuum of all temperature-related events, of which extremes are only a part. With Vicedo-Cabrera et al.'s study and other studies[3,4,6,7] showing the exponential increase in mortality with increasing temperatures, the adequate modelling of future extreme temperatures is essential, yet there is a high chance that current climate models underestimate the number of future heatwaves[8]. Understanding the range, plausibility and drivers of extreme temperatures in the context of health is the key bit of information for decision-makers interested in risk, which is the product of the likelihood of an event, as well as the impact of that event[9]. When the impact of an event increases exponentially, as with the health burden from heat, these low-likelihood, high-impact events often have the highest risks associated with them. To ensure an adequate evaluation of these risks, we must interrogate the causes and nature of extreme temperatures more in future heat–health analyses, whether it be through high climate sensitivity models[9], large sample sizes from individual climate models[10,11] or models with high spatial resolution[12] that are able to resolve relevant fine-scale processes, such as trapping of heat in cities, also known as 'the urban heat island effect'.

The tools already exist to significantly progress understanding of the impact of climate change on human health, and the climate and health communities need to work closely to truly integrate their research ideas, techniques and data, bringing these issues to the fore. The work of Vicedo-Cabrera et al.[3] highlights how important these issues are on a country-by-country level, and it is only by expanding the network of countries involved that we can start to understand the true global burden of heat-related mortality from our changing climate. ❐

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References

1. Watts, N. et al. *The Lancet* **394**, 1836–1878 (2019).
2. Stott, P., Stone, D. A. & Allen, M. R. *Nature* **432**, 610–614 (2004).
3. Vicedo-Cabrera, A. et al. *Nat. Clim. Change* https://doi.org/10.1038/s41558-021-01058-x (2021).
4. Gasparrini, A. et al. *The Lancet* **386**, 369–375 (2015).
5. Åström, D. O., Forsberg, B., Ebi, K. L. & Rocklöv, J. *Nat. Clim. Change* **3**, 1050–1054 (2013).
6. Mitchell, D. et al. *Environ. Res. Lett.* **11**, 074006 (2016).
7. Lo, Y. T. E. et al. *Sci. Adv.* **5**, eaau4373 (2019).
8. Freychet, N. et al. *Commun. Earth Environ.* **2**, 28 (2021).
9. Sutton, R. T. *B. Am. Meteorol. Soc.* **100**, 1637–1642 (2019).
10. Deser, C. et al. *Nat. Clim. Change* **10**, 277–286 (2020).
11. Mitchell, D. et al. *Nat. Clim. Change* **6**, 735–737 (2016).
12. Haarsma, R. J. *Geosci. Model Dev.* **9**, 4185–4208 (2016).

Competing interests
The author declares no competing interests.

CLOUD FEEDBACKS

The cooling of light rains in a warming world

Recent changes to how clouds are represented in global models, especially over the Southern Ocean, resulted in increased climate warming. Correcting rain processes in a model shows improved cloud representation but leads to a greatly enhanced negative feedback, offsetting documented increases in model climate sensitivity.

Graeme L. Stephens

The magnitude of twenty-first-century warming is not solely determined by the radiative forcing of greenhouse gases. Feedbacks play a decisive role, and cloud feedbacks — specifically whether clouds will evolve to warm or cool the climate system — are the largest source of uncertainty of all radiative feedbacks[1]. This is a consequence of the multi-dimensional nature of cloud feedbacks involving a range of properties and mechanistic pathways. Observations, typically in the form of