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OPINION

Preparing for heat risk is complex: Aligning adaptation and mitigation is essential

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Why should the UK be concerned about heat risk?

2023 was the warmest year on record with a global average temperature of 14.98˚C: 1.48˚C above the 1850–1900 baseline [1]. In the UK, 2022 was the warmest year on record, and 2023 the second warmest [2]. The target to limit the increase in global average temperature to well below 2˚C above pre-industrial levels, as outlined in the Paris Agreement, is growing in urgency, particularly as the interim goal to 'pursue efforts' to limit that increase to 1.5˚C is on our doorstep [3].

On 19 July 2022, the UK experienced temperatures over 40˚C for the first time, the UK Met Office issued its first ever red 'extreme heat' warning resulting in the Government declaring a national emergency. The five heat periods that summer led to almost 3,000 heat-related deaths in England [4], the highest number since the introduction of the 2004 Heatwave Plan for England. Without adaptation, and under a high emissions scenario, scientific evidence shows that UK heat-related deaths are estimated to increase by almost 166% (4,266 total deaths per year) in the 2030s, 580% in the 2050s (10,889 total deaths per year), and 1,244% (21,545 total deaths per year) in the 2070s, above a 2007–2018 baseline [5]. The heatwave in England in 2022 was a 1-in-1,000 year event, made ten times more likely due to anthropogenic climate change [6].

The impacts to the UK go beyond affect physical and mental health. Extreme heat affects the economy: over 11 million potential labour hours were lost in the UK in 2022 because of heat exposure across the agricultural, construction, manufacturing, and service sectors. This is further compounded by the design of buildings in the UK which has primarily been aimed at protecting from the cold rather than mitigating the impacts of heat. Rail and road infrastructure are affected by high temperatures in a number of ways leading to higher speed restrictions, delayed and cancelled routes, road closures and congestion where road users then become further exposed to extreme heat and wildfires in stationary vehicles. Water and energy infrastructure can be affected by a surge in water and energy demand for cooling, as well as power cuts due to pole-mounted transformers and overhead conductors overheating. Heat stress affects the natural environment causing animal casualties and damage to plants, flowers, trees and habitats, further increasing the risk of grass and wildfires. This also affects nature's ability to produce crops (impacting food production, disrupting supply chains and affecting food prices), and can reduce the shading and cooling capacity of trees, plants and green spaces [7].

Whilst summer 2022 broke records, and summer 2023 was far less extreme for the UK, heatwaves are projected to become more severe, longer and frequent in future. But we should also consider the impacts of heat at lower temperatures, as we don't need to experience 40˚C heat to see significant health impacts, particularly as most buildings in the UK are not

equipped to deal with extreme heat and lack adequate ventilation and cooling [8]. This is why resilience to heat needs to be considered as a year-round issue, not just specific to summer months and with consideration for the broader impacts to society, infrastructure, the built environment and the natural environment.

The impacts of extreme heat are made worst by a range of factors such as political and economic constraints, compounding and cascading risks, inadequate building and infrastructure design, a lack of understanding about heat-related impacts among the general public and healthcare workers, underlying health conditions of vulnerable populations, and misleading positive messaging about heatwaves in the media [9].

Decision-makers and practitioners, including emergency responders, medical professionals, third sector and local government, working on the frontline of the heatwave response have made it clear that England is not ready for future extreme heat events. They indicated that the 2022 heatwaves, particularly the highest temperatures in July 2022, stretched the health response to its limit [8]. Similarly, public engagement on the issue is lacking, with limited, and time-bound awareness of how the heat affects individuals and can make them vulnerable to its impacts [10].

What should be done?

The most effective way to minimise the longer-term impacts of extreme heat is through the reduction of greenhouse gas emissions, which determines by how much the global climate is changing. This would, in the longer term, reduce the impact climate change will have on the weather. However, even if many country's plans, including the UK's, to reach net zero by 2050 are met, they will still continue to warm, weather extremes including heatwaves will become more frequent, longer in duration and of greater magnitude. A range of responses that target nature-based measures, property measures, urban measures, health measures and preparedness and response are required to reduce avoidable impacts, shift culture and behaviours, establish synergies and enhance resource for short and long-term responses [8].

Policies directly and indirectly related to the UK's response to heat are fragmented and do not adequately address the severity and urgency of this risk, particularly when temperatures exceed those experienced in summer 2022. There is a governance gap on managing the risk of extreme heat, with no clear coordination between policies, and across government departments, at local, regional, and national scales. While implementing an integrated response is challenging it is vital that this is prioritised by government, and those driving responses, given the urgency of preparing for heat risk.

There are high economic benefits to accelerating adaptation and many early adaptation investments, such as heat alerts and heatwave planning, capacity building and making new infrastructure resilient, deliver high value for money. Public engagement on heat risk has improved in England, however more is needed to enable individuals to determine their own level of risk to extreme heat.

Aligning adaptation and mitigation efforts

Preparing for heat and adapting to its impacts must be aligned with addressing the root of the problem: reducing global greenhouse gas emissions [11].

Caution must be taken, as some measures, although required to reduce carbon emissions may lead to unintended consequences for overheating if not properly designed, such as increased air tightness without improved ventilation in buildings. Wider consideration for the interlinkages between adaptation and mitigation action are required to avoid unintended consequences, maladaptation and malmitigation, while effectively tackling overheating.

Better integration between heat risk adaptation and efforts to mitigate climate change is therefore essential. For instance, efforts to improve insulation of homes and offices (to keep them warm in the winter) could increase the risks of overheating in summer without improvements in cooling and ventilation. A reliance on air conditioning is likely to increase and be costly, and potentially unaffordable for those on the lowest incomes, and would lead to a significant increase in electricity demand, resulting in increased GHG emissions, with potential risks for the power grid and increasing local ambient temperatures. The cost of some actions to reduce overheating risk can be shared with those that also improve energy efficiency. The use of passive cooling methods that do not consume energy (e.g. planting trees, architectural design), raising energy efficiency standards and improving existing cooling technologies (e.g. air conditioners), is required.

In order to support this alignment of adaptation and mitigation policies, more work is required to understand the enablers and barriers that decision-makers face when seeking to adopt such an approach to enhance preparedeness to heat risk (Table 1).

Table 1. Considerations for aligning adaptation and mitigation to enhance preparedness to heat risk.

Governance	Framing and cultural shift
Heat affects geographies, scales, actors and processes in different ways and calls for designing and adopting approaches beyond one specific scale (e.g. local) and to ensure wider (e.g. regional and national) buy in and leadership. For example, nature-based solutions demonstrate how adaptation and mitigation approaches can be combined, where street trees can provide shade and cooling (and reduce surface water flooding) while helping to reduce emissions across boundaries.	Adaptation is less well understood than mitigation, requiring a different communication process than what has been adopted for mitigation. Both mitigation and adaptation as concepts can be daunting to those less familiar with them and how they can be implemented individually, let alone in unison. Framing this in the context of responding to extreme heat can help shift behaviours and culture, whilst highlighting some of the intrinsic complexities that can emerge.
Inter-dependencies	**Policy synergies**
There are often different and/or conflicting interests and priorities among decision-makers from the public, private and third sectors, across scales, lacking a systemic approach to align these or to understand the co-benefits of interventions, unintended consequences, gains and losses that could emerge. This can lead to a lack of action due to not fully understanding what these outcomes might be; however this inaction can then lead to further maladaptation or mal-mitigation. Co-production processes and sustained engagement should be facilitated to avoid this and move away from siloed working.	Complementarity of policy processes and action to prepare for heat risk needs to be prioritised where opportunities and issues can be identified across policy areas (e.g. energy, built environment, health etc.). There are multiple injustices and examples of inequality when looking at heat risk impacts and responses (e.g. access to cooling whether it be through air-conditioned work environments or access to green spaces). Being aware of these can provide windows of opportunities for short and long-term, inclusive policies to better align mitigation and adaptation.

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