



## Exploring heat risk adaptation governance: A case study of the UK

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### ABSTRACT

Rising temperatures exacerbated by climate change are a growing concern in the UK. This paper assesses the state of heat risk governance in the country through an analysis of the Adverse Weather and Health Plan (AWHP) launched in 2023, which replaces the former Heatwave Plan (HWP) for England — the prominent policy for addressing heatwaves in the UK. Through 17 semi-structured interviews with key stakeholders, the paper assesses the perceived effectiveness of the new plan in addressing heat risk. The findings demonstrate that AWHP has been positively received and is considered to have well-functioning institutional arrangements and strategies tailored to manage immediate heat risks. However, areas for improvement are identified: the need to enhance public communication and broaden the cross-sectoral understanding of heat impacts beyond the domain of 'health'. Further, the research reveals gaps in leadership, institutional structure, delineation of roles and responsibilities, and funding and resources for addressing long-term heat risk and preparedness in the UK. The paper explores these and highlights the need for strengthening governance and capacity to tackle the multi-dimensional climate risk, i.e., heat, effectively.

### 1. Introduction

The impacts of global warming are evident in the increasing and projected increase in intensity and duration of heatwaves globally (Seneviratne et al., 2023). Several countries in Northern Europe, Canada and New Zealand are anticipated to experience the most substantial relative increase in uncomfortably hot days (Miranda et al., 2023). Amongst this group, the UK, Norway, and Switzerland are 'dangerously unprepared' for heat (Miranda et al., 2023). Conforming to this observation, the UK has witnessed the warmest ten years since 1884 post-2002, with 2022 being a record-warm year, extreme temperatures changing more rapidly than the average, and prolonged warm spells in recent years (Kendon et al., 2023).

Episodes of hot weather are associated with several negative impacts, including physiological stress, heat illnesses, higher rates of hospital admissions and even mortality (Johnson et al., 2005; Smith et al., 2016; Tipton et al., 2023). Estimates suggest that 2% excess deaths can occur in summer for every 1°C above the daily average temperature (Arbuthnott and Hajat, 2017) but evidence also demonstrates that heat-related deaths can occur outside heatwave and summer periods (ONS, 2023). During the record-breaking heat periods in 2022 in the United Kingdom (UK), close to 3000 heat-related excess deaths were

recorded in England (excluding COVID-19 deaths), the highest in a given year (UKHSA, 2023b). This number is expected to increase to 7000 by 2050 (CCC, 2021b) and 12,500 by 2080 (Hajat et al., 2014) and the risk of a hot summer in the UK is now 45% higher than the average (McKie, 2023).

The consequences of prolonged warm spells are multifold, extending beyond their effects on health and well-being: higher temperatures negatively impact work productivity and the natural environment (Arbuthnott and Hajat, 2017; CCC, 2021a), and they can disrupt emergency services, energy systems and transport infrastructure (CCC, 2021a). As the UK experiences consistently rising temperatures and increasingly hot summers, the issue of extreme heat poses an unprecedented challenge, requiring immediate attention and action.

The existing policy and guidance framework to mitigate heat risk in the UK has been criticised as inadequate, fragmented, siloed and lacking effective coordination (Brimicombe et al., 2021; Howarth et al., 2023). Despite the growing acknowledgement of the need to tackle heat risk in the UK, policy and action on this issue remain largely unaddressed to effectively adapt to and prepare for the risk (Brimicombe et al., 2021; Howarth et al., 2023). Robust governance structures play a vital role in coordinating and implementing policies to mitigate heat-related impacts, not only during heat emergencies but also in the implementation

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of pre-emptive measures and overall extreme heat adaptation. However, responses to extreme heat in the UK are predominantly reactive, rather than proactive and further research is needed to delve into the specifics of adaptation governance for heat risk.

The main policy for responding to heatwaves in the UK is the Adverse Weather and Health Plan (AWHP), which replaces the prior approach initiated in the Heatwave Plan (HWP) in 2004 (latest update: 2022). The HWP relied on temperature thresholds to determine alert levels, whereas the AWHP utilises an impact-focused system. This paper assesses the new plan and investigates its perceived effectiveness in mitigating immediate heat risk as well as accelerating long-term heat adaptation. The analysis examines the planning approach, institutional arrangements, stakeholder engagement and implementation to critically evaluate the perceived effectiveness and in turn, the role of robust adaptation governance in mitigating heat risk in the UK.

Section 2 provides a critical analysis of the literature on the impact of higher temperatures, public perception of heat risk, the heat policy landscape in the UK, and adaptation governance. Section 3 details the methodology undertaken, while Section 4 evaluates the new plan and presents the findings on the new plan's perception and adoption, and various aspects of heat risk adaptation governance. Section 5 reflects on the outcomes, examines the gaps, and highlights potential improvements to the heat risk policy and governance framework.

## 2. Literature review

### 2.1. The impact of higher temperatures and perceptions of heat

Since the record-breaking 2003 heatwave in Europe, researchers have increasingly focused on regional heat risks. Numerous studies have established a clear link between warmer temperatures and adverse health outcomes (see Armstrong et al., 2011; Basu, 2009; Basu and Samet, 2002; Watts et al., 2018). In 2019 alone, approximately 356,000 deaths worldwide were associated with extreme heat (The Lancet, 2021). A Europe-wide study that compared the mortality linked with the heatwaves of 2022 and 2003 found that despite the experiences of the 2003 summer extremes, preparedness and response were largely inadequate to tackle the 2022 heatwaves (Ballester et al., 2023). The study highlighted the UK's status among countries with the highest heat-associated mortality (Ballester et al., 2023), aligning with growing evidence indicating an increase in heat-related deaths when temperatures exceed threshold values (Arbuthnott and Hajat, 2017; Thompson et al., 2022). This has a substantial economic cost of approximately £6.4 billion per year in the 2020 s, projected to increase to £13.7 billion per year in the 2050 s (Howarth et al., 2023; Watkiss et al., 2021). Besides mortality, heat is linked to health issues such as exhaustion and respiratory, cardiovascular and mental health concerns (Filho et al., 2018; Watts et al., 2018).

Heat particularly affects vulnerable groups including the elderly, children under the age of 5, and individuals with pre-existing medical conditions, among others who are at risk during extreme heat events (Friends of the Earth, 2022; Kennedy-Asser et al., 2022; Nayak et al., 2018; Smith et al., 2016; Watts et al., 2018) and 'temporarily' vulnerable individuals, including pregnant women and workers directly exposed to heat (Tipton et al., 2023). Heat vulnerability is also shaped by socio-economic factors like income, ethnicity, and location, exacerbating the impacts of heat risks on different populations (Friends of the Earth, 2022; Hansen et al., 2013; Kennedy-Asser et al., 2022; Ogunbode and Kidwell, 2022).

While the health impacts of increasingly hot weather are well understood, there is a paucity of research on its broader implications beyond the realm of health. A notable exception is a study by Arnell et al. (2021) on how higher temperatures impact other sectors, including energy, transport and agriculture. Numerous studies have explored the public perception of heat risks (Abrahamson et al., 2009; Roberts et al., 2022; Wolf, Adger, and Lorenzoni, 2010; Wolf et al., 2009). Some have

concluded that the public does not wholly understand the risk (Bassil and Cole, 2010; Erens et al., 2021; Wolf, Adger, Lorenzoni, et al., 2010) with one study showing that 2 in 5 adults had not seen information on hot weather protection (BRC, 2021). Additionally, even with sufficient awareness of heat risk, people may not always adopt mitigating measures (Bassil and Cole, 2010). An online survey conducted after the 2013 heatwave found that the elderly and low-income groups, despite being at risk, were less likely to take protective measures (Khare et al., 2015). This is especially pronounced in the UK where people tend to associate hot weather with 'good times' (Howarth et al., 2019; Roberts et al., 2022). Limited awareness and preventive behaviour can leave the population under-prepared for extreme heat events (EAC, 2018). Improved public perception is crucial to mitigate negative health impacts (McLoughlin et al., 2023), emphasizing the need to integrate behavioural and social insights into policy development (Howarth et al., 2019).

### 2.2. Heat policy landscape in the UK

Heat extremes in Europe are likely and more intense due to anthropogenic climate change (Ebi et al., 2021; Kovats et al., 2014; Stott et al., 2004; Vautard et al., 2019). Given the expected increase in the frequency and intensity of heatwaves (BRC, 2021; IPCC, 2012, 2014), adaptation plays a critical role in shaping the response to this climate change impact. This involves integrating heat adaptation into medium and long-term growth agendas through governance and institutional reforms, heat-sensitive urban planning, greening, nature-based solutions, and resilient health infrastructure (Boeckmann, 2016; Boeckmann and Rohn, 2014; Duenwald et al., 2022; IPCC, 2023). Without adaptation, heat-related deaths could reach 7040 by 2050 in a 4°C warming scenario (Kovats & Brisley, 2021) and by the end of the century, there could be a total loss of 0.4% of Gross Value Added (GVA), amounting to £1.6 billion to the urban economy in London due to warm temperatures if the city does not focus on adaptation (Costa et al., 2016).

Heat risk is one of the eight priority risk areas identified in the 2022 Climate Change Risk Assessment (CCRA), which assesses climate risks and opportunities for the UK (HM Government, 2022), and a key focus of the UK's third National Adaptation Programme, a five-year strategic outline detailing the country's climate adaptation initiatives, guided by CCRA (HM Government, 2023). Further, a study involving 17 Local Resilience Forums (LRF), established under the Civil Contingencies Act 2004 to enable collaboration among emergency planners at the local level (CCS, 2013), demonstrated that heatwaves emerged as a severe weather event that they were the least prepared for (Cox and Crouch, 2017).

Heatwave planning and response systems are functional in many countries such as Germany, France, Spain, etc. and cities such as Ahmedabad, New York, Male, etc. (Magotra et al., 2020; Vanderplanken et al., 2021). Within heatwave planning, early warning and response systems prove beneficial by offering crucial time to implement proactive measures and mitigate the impacts of heatwaves in many cases. As remarked by Martinez et al. (2019), there is a call for further research to identify potential hindrances to the effectiveness of heat-health planning and its governance for a more substantial impact.

A major policy for responding to hot weather in the UK was the 'Heatwave Plan (HWP) for England', a strategic framework jointly produced by the UK Health Security Agency (UKHSA; formerly Public Health England), NHS England and the Department for Health and Social Care (Howarth et al., 2023; UKHSA, 2022; Williams et al., 2019). The HWP was first introduced in 2004 following the severe heatwave in 2003, aiming to "prepare, alert and prevent the major avoidable effects on health" during hot periods (PHE, 2015, p. 4). The plan was a critical document as it set out measures to be undertaken by organisations to mitigate adverse heat-linked health impacts, raise public awareness and protect at-risk groups (UKHSA, 2022).

Limited studies have assessed the HWP. Boyson et al. (2014)

identified that the plan was known to hospital managers but lacked awareness among frontline health staff, indicating a communication gap between managers and frontline staff during heatwaves. Another study investigating the application of extreme weather guidance at the local level by health and social care systems found that planning for heat events is not one of the highest priorities (Wistow et al., 2017). Similarly, Abeling (2015) found that while the HWP was a valuable tool for disaster risk knowledge, it fell short of triggering long-term action to reduce heat risks, and Zaidi and Pelling (2015) concluded that the Plan had not effectively trickled down to the local level in London and that heatwaves are predominantly viewed as an issue associated with the health sector. Supporting this, Brimicombe et al. (2021) added that insufficient evidence hinders the extension of heatwave responses beyond the health sector. Further, Abrahamson et al. (2009) raised concerns regarding the lack of clarity on the roles and responsibilities of stakeholders within the plan. Within the purview of ‘stakeholders’, researchers have highlighted how the governance approach is siloed and lacks coordination (Brimicombe et al., 2021; Howarth et al., 2023). Despite broad and growing interest in heat risk adaptation among policymakers and scholars, there is still little research on the role of the main policy instruments (i.e., heatwave plans) in strengthening governance. One main reason perhaps is that the literature on heat risks in the UK is fragmented across different issue areas like mortality, vulnerability and public perception. Further, there is limited research on the impact of the heatwave plan on long-term preparedness and resilience-building to hot weather (Williams et al., 2019).

The heat-health alerts (HHA) were a core part of the HWP and key to

communicating the risk and providing advice on undertaking protective measures. The issuance of HHA followed a cascading pattern from UKHSA and the Met Office to national delivery teams, subsequently reaching regional and local teams, as illustrated in Fig. 1. While the approach has generally been seen as useful in triggering responses amongst agencies, it presented a lack of clear actions in level 3 alerts (Roberts et al., 2022), calling for an impact-based approach to alerts during heat events to trigger appropriate responses (Roberts et al., 2022).

A new Adverse Weather and Health Plan (AWHP) was first deployed in June 2023 with an impact-based approach (UKHSA, 2023a). Given this latest development, this paper provides unique insights, assessing the current plan to understand the changes in approaches, gaps and challenges in its implementation.

### 3. Methodology

This paper addresses two questions: firstly, how does the AWHP 2023 build on the previous HWP plan? And secondly, how effective is the new plan in addressing heat risk?

Semi-structured interviews were conducted, using a pre-determined set of questions to guide the discussion on heatwave risk, planning and policy while enabling the participants to respond freely. The UK interviewees were sampled from three categories — policymakers involved in policy and heatwave plan formulation both at the national and local levels, practitioners involved in emergency planning and action implementation at the local level and representatives from

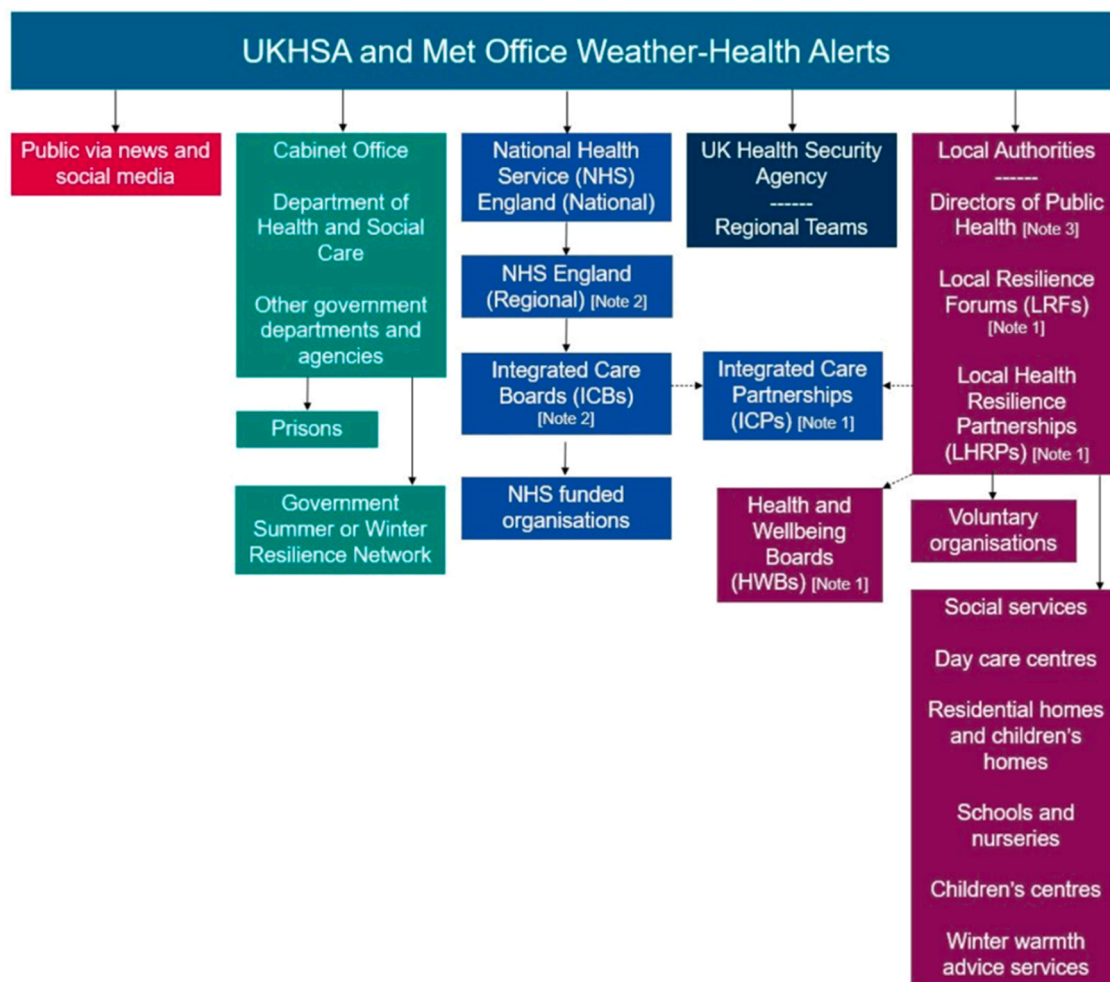


Fig. 1. Cascade of Heat-Health Alerts.

community groups and NGOs who have done substantial work on heat-related events. The choice of sampling interviewees from pre-defined categories was influenced by the strategy adopted by Howarth and Monasterolo (2016) who take a knowledge co-production approach by engaging actors from various institutions, integrating diverse perspectives, experiences and expertise of stakeholders involved in all tiers of policy structure.

In total, 17 interviews were conducted with policymakers (n=6), practitioners (n=9) and community groups/NGOs (n=2). Institutions or organisations represented by the participants included national agencies, local government authorities, Local Resilience Forums, a statutory health organisation, a political organisation, a transport organisation, a climate advisory body, a non-profit research entity and a charity organisation. Three participants were suitable for both the ‘practitioners’ and ‘policymakers’ categories, but their organisational

policy roles aligned better with the ‘policymakers’ category.

The interviews, based on literature review and policy documents, explored reflections on the two plans, effectiveness, implementation challenges, areas for improvement, and impact on heat resilience and climate adaptation. Interviews, each lasting 30 minutes, were conducted virtually on MS Teams, recorded, and transcribed with participant consent. Anonymity and confidentiality were preserved using identifier codes: Policymaker (PO1, PO2, etc.), Practitioner (PR1, PR2, etc.), and Community Group/NGO (CG1, CG2).

Transcripts were coded using NVivo software, and a thematic analysis with an inductive coding approach alongside grounded theory was adopted to organise the data into themes and sub-themes.

**Table 1**  
Comparing the two plans.

Aspect of Plan	Adverse Weather and Health Plan 2023	Heatwave Plan 2004
Timeline	Published in 2023	Published in 2004 (last updated-2022)
Scope	Focuses on extreme heat, cold and flooding events	Focused on extreme heat events
Alert System	Heat-Health Alert (HHA) in partnership with the Met Office	HHA system distinct from Extreme Heat warning issued by the Met Office
Alert Approach	Based on impacts and the likelihood of their occurrence	Based on temperature thresholds
Alert Levels	Green (preparedness) Yellow (response) Amber (enhanced response) Red (emergency response)	Level 0 - long-term planning Level 1 - heatwave and summer preparedness Level 2 - alertness and readiness Level 3 - heatwave action Level 4 - emergency response
Visual Representation of Alert Levels	<p style="text-align: center;">Likelihood</p> <p style="text-align: center;">Impact</p>	
At-risk Groups	<ul style="list-style-type: none"> <li>Includes a broader range of at-risk groups supported by evidence on ‘health inequalities’</li> <li>People over 65, babies and young children, underlying health conditions, serious mental health problems, certain medications, already ill and dehydrated, alcohol or drug dependence, extended time outside, manual labour, homeless, isolated and under care</li> </ul>	<ul style="list-style-type: none"> <li>Includes people over 75, female, living on their own and isolated, severe physical or mental illness; urban areas, south-facing top flat; alcohol and/or drug dependency, homeless, babies and young children, multiple medications, and over-exertion</li> </ul>
Communication Cascade	Combined alert from UKHSA and Met Office to delivery groups at all levels	Distinct alerts from Met Office and UKHSA to delivery groups at all levels
Concurrent Incidents	<ul style="list-style-type: none"> <li>Limited mention of wildfires</li> <li>No mention of air and water quality</li> <li>Next iteration to include drought, thunderstorm asthma and storms</li> </ul>	<ul style="list-style-type: none"> <li>Potential for wildfires highlighted</li> <li>Possibilities of poor air quality and water quality highlighted</li> <li>No mention of drought, thunderstorm asthma and storms</li> </ul>
Impacts on other Sectors	Does not include specific impacts on other sectors besides health	Includes a section on the anticipated impacts for other sectors (transport, power, utilities, animals, water, etc.)

## 4. Findings

### 4.1. New plan perception and adoption

*“It is quite strange to see a change (referring to the new plan) that is helpful. We don't get those very often.” (PR1)*

The AWHP was unanimously seen as a welcome change for three key reasons. Firstly, combining the guidance shared for heat (heatwave plan) and cold (cold weather plan) events in one broader plan has brought better consistency across severe weather types. While there were clear differences in which adverse weather each plan was addressing, there were several commonalities in how stakeholders approached the weather challenges. [Table 1](#)

Secondly, the new plan addressed the misalignment of Heat-Health Alerts (HHA) and Extreme Heat (EH) warnings in the previous plan by ensuring these warnings are aligned, disseminating a ‘single overall message’ for the users. HHA in the previous plan covered yellow to red alerts while EH had amber and red; health actors followed HHA and others followed EH. This variation increased the responsibility of local actors to interpret the alerts and then take decisive action, potentially causing inconsistencies and delays.

*“We are pleased with the new update to the plan, which is now closely linked to how the Met Office forecasting and the national risk assessment are presented. Having that common understanding and way of presenting different risks is helpful.” (PR9)*

Thirdly, moving from alerts based on temperature thresholds to impact-based alerts displayed in a risk matrix, constituting the potential impacts and the likelihood of these impacts occurring, is considered effective. The matrix enables the emergency planner to decide their response actions appropriately. This approach is expected to avoid the uncertainty and ‘alert fatigue’ of too many alerts caused by the previous approach.

Additionally, while the risk information and response action associated with each level have remained consistent, the change primarily lies in how they are presented, rendering the new plan's content and narrative much clearer and easier to digest for emergency responders. However, it was observed that the methodology used to arrive at the information presented in the matrix was not communicated to users, resulting in some degree of ambiguity.

While the incoming plan was received positively, its adoption posed some challenges. Five participants mentioned that the plan did not have sufficient lead-in time for a smooth transition. Contextualising the national plan to react to the local conditions is a crucial step in the delivery and implementation process. However, since the new plan landed at short notice, most delivery group members were unable to localise the plan in time for the summer alerting season.

*“We currently have the hot weather plan (old plan) because the plan was updated close to the heat period starting.” (PR7)*

*“We're just having to go with it. As you can see (shows me the local plan), the plan is not finished. So, we're doing a hybrid now with the old plan still in place with the new alerting system.” (PO3)*

### 4.2. Communication

The dissemination of information and the associated communication materials of the new plan to emergency planners was seen as improved. A few respondents found the launch and summer preparedness webinars for the stakeholders quite useful, suggesting there has been an increased focus on ‘capacity building’ in the AWHP.

On the other hand, public-facing communication was considered inadequate and challenging. Over the years, people's awareness of heat risks has significantly increased. However, the local actors do not have a good grasp of how well the messages are getting through because the

awareness does not necessarily translate into people taking protective action. Moreover, public perception of hot weather being ‘enjoyable’ is a barrier.

*“A complicated arena (referring to public messaging) because you've got almost a natural resistance to plan for something that's seen as positive.” (PR2)*

*“We don't seem to have a shift in public behaviour. So, I think the main challenge is trying to get the messages out when public perception is like, Oh, I'll have a barbecue, it's wonderful weather.” (PR5)*

The lack of readily discernible, tangible impacts of heatwaves, unlike other severe weather events like floods, adds to the complexity.

*“During flooding, there's obvious damage. With heatwaves, we don't get that. There might be pressure on health partners. But we don't see a clear emergency impact scene. Because we're talking about individuals in their own or cared-for accommodation struggling. It is more hidden.” (PR6)*

Furthermore, the individual impact of hot weather tends to vary widely, making it harder for the key actors to visualise and appropriately respond. Recollecting the experience of the heatwave in 2022, a participant commented:

*“...not fully understood how many people would be vulnerable, whether they fell into a standard vulnerability definition. It was interesting that those vulnerability categories were potentially much wider than expected and changed very quickly. People who weren't vulnerable at the start of the heatwave became affected after 24 or 36 hours.” (PR9)*

Despite an improved understanding of different vulnerable demographics in the new plan, a challenge persists in communicating the heat risks. For example, during hot weather, general advice may suggest seeking shaded outdoor spaces if overheating occurs indoors. However, when air quality is compromised, for individuals with respiratory conditions, staying indoors and sealing windows may be advised, which goes against the broader public messaging. Moreover, engaging with people whose vulnerability is shaped by socioeconomic factors may look different. The complexity of public-facing communication intensifies during concurrent incidents. Consider flash floods followed by a heatwave; this dual conundrum makes it even more challenging to prepare the public for different events simultaneously.

### 4.3. Heatwave preparedness and response

LRFs, county councils, local authorities and other actors recognise heatwaves as a prominent high-risk scenario. In a typical emergency planning cycle, the National Risk Register is referred to for risk assessment and brought down to the local level alongside the national plan (i. e., AWHP). The AWHP has components for preparedness, including risk information, early warning through alerts and response measures. Given the plan's primary focus on immediate heat impact mitigation, all participants perceive the plan as a foundational framework for emergency planning efforts. This plan is deemed ‘responsive’ to expected or ongoing severe heat events, serving as a cornerstone for preparedness strategies.

*“Our action is immediate impact mitigation. When something happens, you stand up quickly and respond.” (PR2)*

*“Generally, people see it as a response plan.” (PR9)*

While the plan is generally viewed as effective and useful for addressing typical heat-associated incidents, all nine participants under the ‘practitioners’ category raised concerns about how the plan can dovetail response actions in the event of concurrent incidents like wildfires, thunderstorms, flash flooding, drought and poor air quality.

*“You could have multiple events happening at one time and if you had different procedures in place, that would be slightly a nightmare.” (PR7)*

Addressing the concern of managing concurrent incidents more

effectively, a participant representing UKHSA said the initiative to include drought, storms and thunderstorm asthma is in the pipeline.

#### 4.4. Institutional arrangements

The institutional structure forms a key component in the dissemination of information and early warnings. The HHA cascade from UKHSA and the Met Office to stakeholders at different levels, this remains consistent with the previous plan. In alignment with assigned roles and responsibilities, diverse multi-agency stakeholders collaborate and undertake various actions, including further alert cascading, coordination or public messaging, among others.

According to most participants, this communication cascade appears to function seamlessly. However, two caveats were raised. Firstly, the extent to which communication trickles down to the final tier remains uncertain. A participant shared an anecdote of his interaction with two actors within the NHS, one an emergency planner, and the other not, with varying levels of information about the alerts:

*“My wife, who works for the NHS, who’s not an emergency planner said what happens with heatwave alerts doesn’t get to them. That’s slightly worrying because I spoke to another colleague, who works in the NHS and who is an emergency planner and they said yeah, all we do is tell people to sign up for the Met Office alerts because they’re busy looking after patients. When down to a ward setting, you wonder how it’s cascaded through other agencies.” (PR8)*

Secondly, regarding the effectiveness of the information cascade and the extent to which actions are diligently executed. This stems from the fact that the information comes through different layers of actors with each council adopting distinct strategies. A participant within an LRF shared insight into the forum’s partners disseminating public messaging with varied efficiency:

*“We see some proactive messaging, and then we see others where I’m not entirely convinced that the message has been relayed. This is within an area, probably less than 50 miles apart.” (PR6)*

Another significant aspect of the discussion revolved around the plan’s focus on health. While this health-centric approach garners acknowledgement and support, some participants shared their apprehensions about its potential inattention of impacts on other critical sectors like transport, utilities and water. A participant illustrated the effects of heatwaves on railways, indicating the broader spectrum of influences.

*“There’s the expansion of the rail, which can distort the track. If the soil is dry, it is more likely to have landslips. These can lead to derailment and crashes. That’s a huge risk for us.” (PR3)*

An LRF representative explained how better awareness of sectoral impacts arises only through local agency meetings after which the response efforts begin.

*“We invite all our LRF partners to share inputs about their specific issues. That’s how we learned that cables bend in hot weather and there’s an increase in water usage. That helped us conduct a multi-agency risk assessment and then share those warning-informing messages.” (PR5)*

Other sectors often have their distinct frameworks for heatwave responses, diverging from AWHP. This has implications for how coordination plays out at the local level. In the web of institutional arrangements, it becomes the responsibility of the local actors to distil inputs from different sectors, which are not in one place, into their local strategies. This might place the local actors in a potentially disadvantageous position, responding reactively to mitigate impacts on other sectors that inevitably affect people, as put forward by a participant.

*“When the heatwave is on its way, we focus on health. It’s only when sectors start to tell us the impacts, we start to respond. Often it feels like we*

*might be on the back foot, and it would be more useful to have positive assurance in advance.” (PR6)*

#### 4.5. Long-term planning

All participants emphasised the imperative of long-term planning, resilience building and climate adaptation to effectively tackle the escalating risk of hot weather.

*“We need to think seriously about adaptation and start now. Ideally, we should have started about 10 years ago.” (PR6)*

Within this context, the AWHP incorporates a policy development and accountability component that discusses heat risks within the realm of climate adaptation policies. While the need to address long-term climate risks is recognised, the plan is primarily perceived as a tool for emergency response and short-term actions, largely utilised by emergency planners.

*“That’s (climate adaptation) not the job of that plan and it’s not the job of emergency planners. But then that leaves you with a gap into climate change impact because we’re not very well tied up with long-term strategies.” (PR2)*

The complexity of cross-disciplinary collaboration is further amplified by what the participants call a lack of ‘ownership’. A clear delineation of responsibilities concerning adaptation is notably absent, leading to uncertainty both at national and local levels. This ambiguity affects how different agencies undertake heat risk mitigation efforts. As voiced by most participants, heat risk is not tied to a single agency. However, the lack of a lead role in addressing this risk introduces challenges, particularly in local-level strategy implementation.

*“It can also be quite challenging to identify which agency should have primacy. There’s nobody to hold the ring.” (PR5)*

*“I think there are some challenges around how or where policy sits. And who’s got to be genuinely driving it, holding it to account?” (PR6)*

*“There’s no regulator for heat. It’s a difficult one.” (PO4)*

*“...to approach somebody in another organisation and say, are you thinking about this (heat risk adaptation) knowing full well, that maybe, there might not be anybody in that organisation whose job it is to think about this.” (PR4)*

The challenge extends to local authorities responsible for climate adaptation strategies. Six participants highlighted that they were not well-resourced. A participant provided insights into the overburdened institutions and how this pressure is bound to escalate unless timely adaptation measures are executed.

*“We know the direction of climate change. If we don’t adapt longer term, the pressure on response is going to increase. We’re already struggling. .... As LRF, we’re not resourced to do that preventive work.” (PR6)*

Adding to these challenges is an inadequacy of funding, further stalling the progress of adaptation efforts.

*“Local authorities cannot establish local delivery networks (for adaptation implementation) in the absence of funding.” (PO2)*

*“Adaptation receives very little funding. Without a governance framework and funding, it’s very difficult for people to sign up.” (PO4)*

## 5. Discussion

The data highlight the positive reception of the new plan (AWHP 2023), which replaces the Heatwave Plan. The new plan differs from its predecessor primarily in terms of its cumulative approach to adverse weather events (i.e., including heatwaves, cold weather and flooding)

and the shift from temperature thresholds-based to impact-based early warning systems. However, adoption of the new plan faced challenges, particularly as its deployment during the summer planning cycle provided insufficient lead-in time to localise the plan, highlighting the complexities of the transition process. This suggests that the shortcomings in effectively translating the national plan to the local level, as well as issues in coordination and communication among actors, previously identified by Brimicombe et al. (2021) and Zaidi and Pelling (2015) persist to some degree.

Additionally, it is important to recognise that heatwaves may not always be standalone incidents. The research shows that heatwaves can trigger or coincide with other events such as wildfires, storms, flash flooding and droughts, compounding the impacts of the extreme heat and leading to other cascading impacts. While the plan mentions the inclusion of storms, drought and thunderstorms in future iterations, there is no mention of wildfires, which have been recounted as an important concurrent risk by most participants. Therefore, there is a need to further expand the comprehensive outlook undertaken by the AWHP towards addressing other associated adverse events related to heat.

The analysis of the Adverse Weather and Health Plan’s effectiveness is structured around communication, heatwave preparedness and response, institutional arrangements, and long-term planning, guided by the main themes and sub-themes derived from thematic analysis of the semi-structured interviews (see Fig. 2), as discussed below.

5.1. Heat as an invisible risk

Heat risk has gained prominence and received greater traction owing to increasingly warmer summers and record-breaking temperatures in recent years. However, this research indicates a critical gap in public perception and safeguarding during hot weather, pointing towards the inadequacy of communication and public messaging mechanisms in place. The research shows that despite a potential increase in the awareness of hot weather as a ‘phenomenon’, there is a lack of this understanding being translated into protective measures during adverse

heat events by the people, emerging from two key reasons. Firstly, people tend to associate hot weather with ‘positive’ feelings. Secondly, the impact of heatwaves is ‘hidden’ and even ‘delayed’ unlike other severe weather events like floods, further hindering the public from recognising the gravity of heat risks. These findings are consistent with other studies (EAC, 2018; Howarth et al., 2019; Wolf, Adger, and Lorenzoni, 2010) noting that public perception is a barrier, indicating a limited shift in the situation has occurred over the years.

The challenge of heat risk being ‘invisible’ particularly affects the most vulnerable as iterated by all participants. Therefore, the strategic response to tackling the challenge lies three-fold – understanding who is at higher risk, how they are impacted and how to raise awareness and protect them from severe impact. While the new plan (i.e., AWHP) has significantly expanded on its recognition of diverse vulnerabilities and broadened the list of at-risk populations, the understanding of the differential impact of heatwaves on these groups and the approach to be undertaken to protect them through tailored communication and other interventions remains unclear. This underscores the need for strengthening the evidence base to inform planning, and as put forth by Howarth et al. (2019), reinforces the utility of incorporating behaviour and social insights into policy development.

5.2. Heat as a cross-sectoral and multi-level risk

Heatwaves are predominantly perceived as a health risk in the UK, leading to policies and frameworks focusing on minimising the health impacts of high temperatures. This insight mirrors the observation of Turek-Hankins et al. (2021) citing that treating heat as a health issue is characteristic of high-income developed countries. As the title suggests, the AWHP plan (or HWP), the UK’s most prominent heat risk policy, focuses on health. This thematic emphasis aligns with the national health agency as its primary developer. There are two schools of thought on this matter. One stance reinforces the paramount importance of prioritising health, driven by the substantial health impact of heat on people; deviating too far from health might shift the attention away from ‘people’, who should remain the focal point. The slightly contrasting

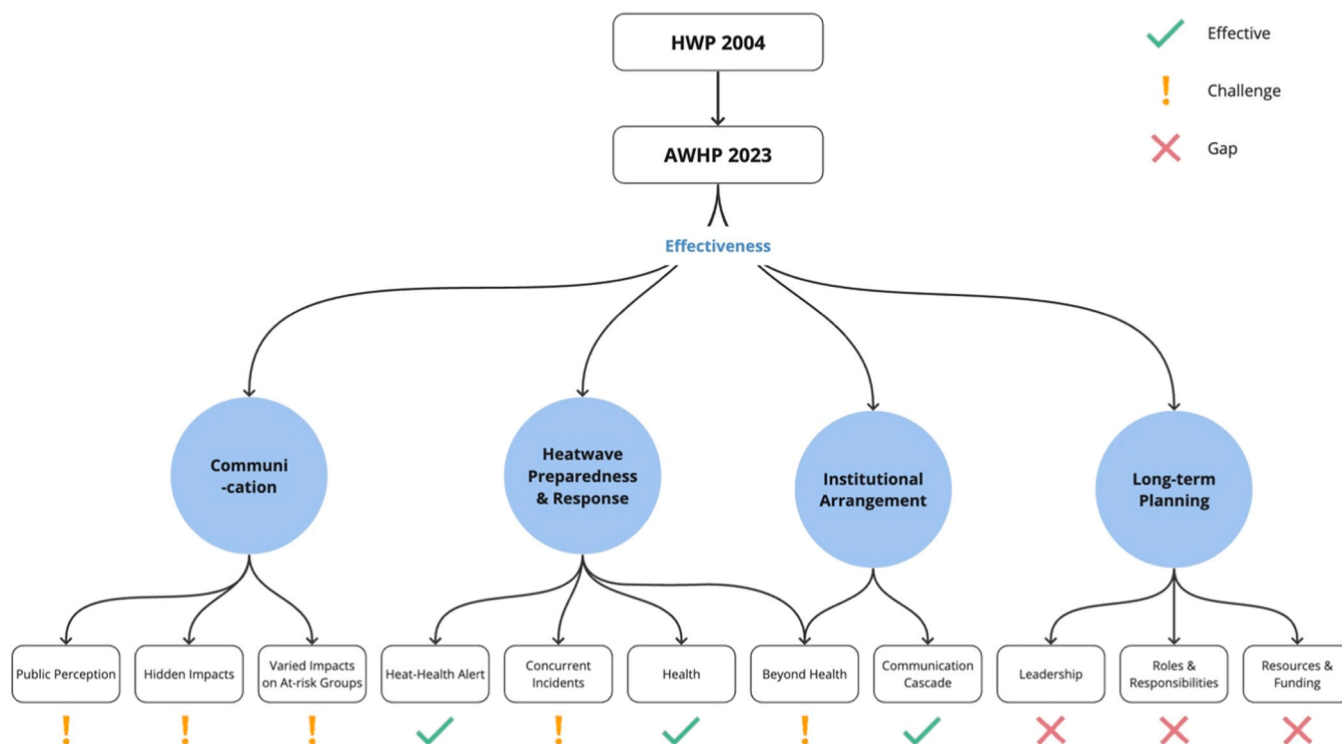


Fig. 2. Perceived effectiveness of AWHP 2023.

perspective draws attention to the challenges emerging from a singular focus on health, possibly overlooking the impact on sectors like transport, water and energy, which, in turn, can ultimately impact people's well-being.

Although cross-governmental discussions occur at the national level among health, education, environment, justice and other relevant agencies (Oliver, 2023), these dialogues often fall short of translating into 'centrally consolidated' guidance disseminated to the local level. Consequently, local actors are required to scale down guidance from different sources to suit local conditions, which can potentially overwhelm these already strained institutions. Moreover, these local actors (LRF, for instance) might find themselves under-prepared when addressing impacts on other sectors during emergencies. A limited understanding of these sector-specific impacts could lead to delays as they wait for their multi-agency partners to share relevant information. Additionally, there are wider determinants of well-being that do not squarely fall under the purview of health. For example, living in a home prone to overheating or lacking the means to access green and shaded spaces can affect an individual's capacity to withstand heat.

Striking a balance in this heat risk conundrum is not uncomplicated. Drawing insights from Termeer et al.'s (2017) perspective on the importance of 'framing the problem' and 'alignment across sectoral boundaries' becomes valuable in this context. Aligning with this notion, and as opined by most participants, while health should remain the primary focus concerning heat risks, a more comprehensive approach is, indeed, beneficial in broadening the understanding of heat impacts on other sectors to ensure that institutions are well-equipped to respond effectively during extreme heat events.

### 5.3. Heat as an immediate and long-term risk

Heat risk is a relatively new challenge in the UK, presenting both immediate and long-term threats under a changing climate. The AWHP has shown promise of effectiveness in handling immediate heatwave impacts, yet remains confined to the bounds of 'emergency response' — a trait also evident in its predecessor, as discussed by Brimicombe et al. (2021), suggesting the 'reactive' nature of the plan remains unchanged.

Though long-term planning and adaptation form a small part of the AWHP, its primary audience of emergency planners limits its utilisation for such purposes. This is consistent with Abeling's (2015) observation that the heatwave plan is a valuable tool for disaster response and management but lacks the capacity for preventive risk planning. That said, it would be an overreach to criticise the plan on these grounds given that it neither falls within the plan's core purpose nor aligns with the primary audience's utilisation.

However, this raises the question: what other policy instruments exist that can prompt a pre-emptive approach to adapting to heat risks? Evidently, the approach to handling the emergency and adaptation aspects of heat risks seems 'siloed'. This division is, in part, due to the many sectors, agencies and actors involved, leading to a distinct separation of roles between emergency planners and climate adaptation experts, with limited convergence.

While there appears to be a consistent collaboration between DEFRA (responsible for NAP) and UKHSA (responsible for AWHP) (PO1), there are caveats in the integration of these policies for coordinated action. Against this backdrop, the research underscores a lack of clear leadership in addressing heat risks. Although UKHSA has assumed a leading role in immediate heatwave response, the same cannot be said for long-term adaptation. Emulating the national level, this lack of clear direction extends to the local level, where roles and responsibilities for long-term planning are not clearly outlined. Unlike the well-defined organisational structures such as LRFs for emergency operations, there appears to be a void when it comes to medium to long-term efforts.

Currently, the onus for climate adaptation at the local level rests with the local authorities and councils. However, this research has revealed that these institutions are not equally well-resourced and lack funding,

specifically for adaptation, aligning with the observations of limited capacity, people and funds for local adaptation by Howarth et al. (2018), further emphasising the need for enhancing institutional capacity.

As highlighted by most participants, heat is a risk that cannot be handled by a single agency. The absence of central leadership for heat-related initiatives along with unclear institutional structures poses challenges. Without a compelling push for cross-communication, there might be a lack of motivation for any entity to go beyond its prescribed mandates to address the risk. This accentuates the importance of delineating clear roles and responsibilities to facilitate effective collaboration. The situation draws attention to Termeer et al.'s (2017) notion of addressing the questions of 'level(s) at which to act' and 'appropriate forms of leadership' being fundamental aspects of developing climate adaptation institutional arrangements. They suggest the need for a range of hierarchical arrangements (national, regional and local) with well-defined coordination processes and structures (Termeer et al., 2017).

A notable step in this direction is the UKHSA's acknowledgement of the need for both short-term and long-term responses to heat risks and the recent creation of a new Centre for Climate and Health Security within the UKHSA, bringing together the expertise of extreme events, climate change and vector-borne diseases teams (Oliver and Ford, 2022; PO1). The potential cascading impacts of this national centre on improving regional and local institutional arrangements and their subsequent climate action remain to be observed.

## 6. Conclusion

This paper has analysed the perceived effectiveness of the 2023 Adverse Weather and Health Plan, which replaced the 2004 Heatwave Plan for England, in addressing heat risks in the UK. By using 17 semi-structured interviews with policymakers, practitioners and representatives from NGOs, the research has found four key insights.

Firstly, the new plan takes a comprehensive approach to address adverse weather events by incorporating heatwaves, cold weather and flooding events into a single framework, unlike its predecessor which focused solely on heatwaves. The early warning approach has also moved from temperature thresholds towards impact-based alerting. These new alerts include the potential impacts of the hot weather along with the likelihood of these impacts occurring. While the new plan had a positive reception, there were certain delays in its adoption, owing to a short lead-in-time, the tedious process of modifying the local plans and possible resource constraints.

Secondly, effective communication is a key element of heat preparedness, yet it poses several challenges. The public's 'positive' perception of hot weather, the 'hidden' impacts of heatwaves and its varying effects on different at-risk groups are some of the noted challenges, which cumulatively create a risk of hot weather being 'invisible', necessitating a stronger emphasis on improved evidence-based and targeted public messaging to protect the people, especially the vulnerable groups.

Thirdly, the approach of centring heatwaves around health security is valid, but there remains a limited understanding of how heat impacts sectors beyond health, posing response and management hurdles at the local level. Therefore, expanding the knowledge of heat's effects on other sectors is essential, which can include better convergence of national sectoral agencies in providing expertise and holistic guidance to create an enabling environment for local actors. This collaboration can occur while maintaining health as a central focus.

Finally, extreme heat events pose both immediate and long-term threats in the context of climate change in the UK. While the AWHP delivers well on addressing short-term heat risks through early warning systems and appropriate institutional arrangements, there is a gap in strategically responding to long-term threats through climate adaptation and resilience-building. The absence of clear leadership and corresponding institutional structure creates a void in the country's response to long-term heat risks, unlike that of emergency operations. Hence,



there is a need to establish unequivocal direction at the national level and define roles and responsibilities at regional and local levels that can enable constructive coordination and collaboration between agencies to implement effective action. This should be complemented by bolstering local institutions with resources and funding for climate adaptation efforts.

As heat-health plans expand to more cities, countries and regions globally, their evaluation becomes crucial. In this context, understanding the positioning of heat risk within key UK policies and assessing their effectiveness and limitations in addressing heat-related threats is of central importance to shaping future policies. With boundaries of disaster response and climate adaptation blurring against the backdrop of climate change, the research plays a useful role in shedding light on the interactions among cross-sectoral and multi-level institutions, thereby, driving improvements to better tackle heat risks and other similar climate challenges. Moreover, the insights derived from this research conducted in the UK can be relevant to other countries where heat-related risks are emerging, including Switzerland and Norway. In addition to applying the insights gained from this research in comparable geographical settings, the understanding of heat planning and governance systems will contribute to assisting a broader international community in assessing and strengthening their own approaches.

However, given the 2023 AHP was only recently launched and considering this is its first iteration, the plan's adoption and implementation may continue, with the full impact not being captured in its entirety in this study. As heat risk governance, policies and institutions continuously evolve (for example, the new Centre for Climate and Health Security at UKHSA), it stands as a limitation to the study in observing their impact.

Moving forward, further research can be conducted to assess how future iterations and newly established institutions shape heat risk governance and action. Additionally, it would be interesting to explore interdisciplinary collaboration, specifically for heat risk adaptation under NAP in the UK. Similarly, undertaking comparative international analyses could help identify areas for improvement to strengthen the climate policy and institutional landscape in the UK.

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## CRedit authorship contribution statement

**Srinidhi Ravishankar:** Writing – original draft, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Candice Howarth:** Writing – review & editing, Supervision, Methodology, Investigation, Conceptualization.

## Declaration of generative AI and AI-assisted technologies in the writing process

The authors declare that no AI and AI-assisted technologies were used in the writing process.

## Declaration of Competing Interest

The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: Candice Howarth reports financial support was provided by Economic and Social Research Council. If there are other authors, they declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Data availability

Data will be made available on request.

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