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Public health: a forgotten piece of the adaptation law puzzle

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This paper uses the problem of extreme heat to illustrate the inadequacy of laws for protecting public health under climate change. Climate change is already having serious effects on public health. The Intergovernmental Panel on Climate Change (IPCC) Sixth Assessment Report highlights significant adaptation gaps for human health protection, urging that public health adaptation must be 'proactive, timely and effective'. The law can be a powerful tool for advancing adaptation to protect public health, but there has been very little scholarly analysis of its potential, or whether in some circumstances it may promote maladaptation. For example, legal regimes for land use planning typically respect existing uses of property and make retrofitting for climate-proofing hard to mandate. These regimes can take many years to amend so new infrastructure continues to comply with outdated approaches, such as relying on air conditioning for cooling and offering limited shading. Laws also promote a focus on crisis management during a heat event but fail to promote the preventive action necessary to foster resilience. We present a case study of how the law exacerbates public health risks from extreme heat and falls short of facilitating adaptation in the Greater Western Sydney region of Australia, an area with a population of 2.6 million. In 2019, this area experienced a record near-surface air temperature of 52°C (125.6°F) causing significant adverse physical and mental health impacts. The public health impacts of extreme temperatures in this region are well documented, as are the increasing strains on emergency and health services. This case study demonstrates that laws could help to control heat in the landscape and secure the safety of vulnerable populations, but to do so they must prioritize adaptation to the health impacts of climate change.

KEYWORDS

public health, law, adaptation, health impacts of climate change, extreme heat

1 Introduction

Climate change is having serious effects on public health. The IPCC Sixth Assessment Report documents a range of climate-driven health threats, including droughts, floods, heatwaves, bushfires, food and water insecurity, deterioration of air quality and rising rates of infectious disease (Cissé et al., 2022). These health threats cause physical injury, respiratory illness, dehydration, heat stroke, heart attack, higher rates of mental illness and death (Pörtner et al., 2022). Heat-related health impacts are one of the most significant global health risks posed by climate change (Cissé et al., 2022). Climate change is also a threat multiplier because, as extreme weather progresses, the interaction of clustering health effects can worsen the course of health problems, and is magnified by social inequality (Boyd, 2017; Mendenhall and Singer, 2019).

The law is a powerful tool for advancing public health action (Gostin et al., 2019) alongside efforts by health professionals. However, to date, public health laws have played a limited role

in facilitating climate adaptation (Burger and Gundlach, 2018; Wiley, 2022). Effective laws are essential for setting clear goals that help to anticipate changing public health and climate conditions and emphasizing the need to prepare for those changes (Ruhl and Robin, 2021). They are also essential for shifting investment and governance effort toward more equitable and collaborative approaches to public health as the climate changes, and away from reactive, siloed emergency management.

This paper uses the problem of extreme heat in Western Sydney, Australia to illustrate the inadequacy of existing laws for facilitating public health adaptation under climate change. Our evaluation of the legal framework applies a unique theoretical framing of what we call 'adaptive public health law' which combines principles of adaptive governance and public health law.

Our combination of theories is both intuitive and revealing. Adaptive governance shares many concepts in common with current approaches to public health governance. Adaptive governance assumes that collaboration among actors and across scales, is necessary to identify what people need and what is best for a socio-ecological system. In most developed nations, protecting and promoting public health requires support from multiple actors across multiple scales, a term referred to in public health literature as solidarity (Dawson and Jennings, 2012; Tomson et al., 2021). Applying principles of public health law to adaptive governance can ensure that adaptive interventions adhere to public health values needed to preserve the conditions of good health in the population as a whole (Gostin, 2016). Combining these two bodies of theory, our 'adaptive public health law principles' include: the need for law to incorporate mechanisms that promote flexibility and responsiveness to changing public health needs; ensuring that public health governance occurs at the most appropriate scale or scales; the importance of prioritizing health equity to reduce vulnerability; and promoting partnerships across sectors to secure public health outcomes using solidarity.

Using these adaptive health law principles, we show how national and state laws are not equipped to manage the growing burden of extreme heat in Western Sydney, a densely populated urban center in the Australian state of New South Wales. Our insights are based on a detailed doctrinal analysis of applicable laws and policies. This research is also informed by novel and detailed insights from semi-structured interviews conducted in 2022, with experts ($n=10$) in public health and extreme heat in New South Wales and Western Sydney.

The article proceeds as follows. Part 2 explains the problem of extreme heat, features of urban form that exacerbate heat, and the health problems created by prolonged heat events. It also introduces the case study location of Western Sydney and explains why extreme heat is a specific problem in this area. Part 3 explains four key adaptation strategies for dealing with the health impacts of extreme heat. We evaluate the legal framework governing each strategy, through our lens of adaptive public health law.

2 Extreme heat as a public health climate change impact

Human metabolic temperature sits roughly around 35°C. Humans function most efficiently in environments below this temperature

(Nairn and Fawcett, 2013) and problems arise for the human body when average temperatures rise over 35°C or remain above 30°C across a 24 h period (Chaston et al., 2022). Heatwaves are generally defined as abnormally hot weather that lasts for a period of 48 h or more (Nairn and Fawcett, 2013). Extreme heat conditions place the human body's normal system processing under significant pressure (Mason et al., 2022). Extreme heat and heatwaves are associated with acute dehydration, multi-organ failure, stroke, difficulty concentrating, heat stress and mortality, among other things (Mason et al., 2022). Heatwaves can be categorized as average, severe or extreme (Chaston et al., 2022), by reference to their likely impact on people, communities, and mortality risk. As temperatures rise in extreme heatwaves, humans and society are at risk of individual problems such as heat stress and mortality (Mason et al., 2022), but also broader social impacts such as increases in food and water-borne disease, violence and higher rates of criminal and aggressive behavior (Stevens et al., 2019; Oppermann et al., 2021).

The features of urban settlement can exacerbate the experience of heat extremes in cities. Heat is trapped by urban materials, such as concrete and asphalt, and urban forms, such as roads, buildings and parking lots. Heat can accumulate over several days in a process known as the urban heat island effect (Khan et al., 2021), from which there is often no night-time relief (Khan et al., 2021).

Systems such as transport, energy and health care that are normally robust and heat-tolerant can also become compromised, complicating the public health impacts of extreme heat. For example, power outages, transport breakdowns and reduced worker productivity were all recorded in Western Sydney during prolonged periods of extreme heat in 2020 (Melville-rea and Verschuer, 2022). Cascading failures in these systems cause other failures, such as overwhelmed emergency and health care systems. Excessive periods of heat can also decrease agricultural production, compromising food security, and proliferate algal blooms in drinking water supply (Keith et al., 2019).

A wide range of characteristics place people at increased risk during periods of extreme heat. For example, the elderly, the very young, and people with cardio-vascular, kidney or lung disease are especially susceptible to heat-related health impacts (Mason et al., 2022). Obesity, some medications, age, gender, aerobic fitness and level of acclimatization also affect the body's ability to shed excess heat and can contribute to the body overheating (Hanna and Tait, 2015). Heightened exposure can also mean that otherwise healthy people are at higher risk of heat-related impacts, including students and office-workers in hot indoor environments, who have been shown to have decreased learning capacity and productivity during extreme heat events. Similarly, people who work outdoors during heatwaves are at heightened risk of heat related illness (Morris et al., 2020).

Like other climate health risks, vulnerability refers to the degree to which a community, individual or organization can anticipate, cope with, resist and recover from climate impacts (National Resilience Taskforce, 2018; IPCC, 2022). Vulnerability to the impacts of extreme heat is a factor of risk exposure and sensitivity (IPCC, 2022) and can be different for people at various times and locations (Coates et al., 2014; Pfautsch and Rouillard, 2019; Pfautsch et al., 2020; Melville-rea and Verschuer, 2022). For example, outdoor workers experience different risks depending on where and when they are working, and what they are doing (Coates et al., 2014).

2.1 The problem of extreme heat in Western Sydney

Australia is already prone to urban heat extremes because high-pressure weather systems block or deflect oncoming low-pressure systems and stall the passage of easterly air flows that move cooler weather from the Southern Ocean across the continent (Lim et al., 2019). However, Anthropogenic warming is greatly increasing the chance of record-breaking extreme heat events and concurrent heatwaves across the country (King, 2023). Many cities in Australia are experiencing a growing number of far-higher than average heat events lasting for three or more days (King et al., 2017).

The impacts of urban overheating are higher in Western Sydney than many other regions in Australia (New South Wales Government Department of Communities and Justice, 2018). The Greater Western Sydney region has a population of 2.6 million, and is located west of the Sydney metropolitan area, in the Australian state of New South Wales. It is one of the fastest growing urban regions in Australia with an expected population of 3.5 million by 2037 (Melville-rea and Verschuier, 2022). Approximately 49 per cent of the population was born overseas, with 170 different countries and 100 languages represented, and 12 per cent of the population in Western Sydney speaking little to no English (New South Wales State Emergency Management Plan, 2018). The region also has a high proportion of low-income families, with some of the lowest education retention rates and highest rates of chronic disease in New South Wales (Capuno, 2015; New South Wales State Emergency Management Plan, 2018; New South Wales Government Western City Parkland; 2021; Figure 1).

Temperatures are frequently 8°–10.5°C higher in Western Sydney than in the eastern part of the city (Khan et al., 2021) because of the surrounding geography and the region's distance from the coast (Khan et al., 2021). In 2019, Western Sydney experienced a near-surface air temperature of 52°C (125.6°F) (Pfautsch et al., 2020). Residents experienced electricity failures, severe and life threatening heat illnesses, melting highway surfaces, transport breakdowns and mental health problems (Gooley and Kontominas, 2019; Bacon, 2021). Chaston et al. (2022) assessed the mortality burden of a high emissions scenario for Sydney and projected a fourfold increase in the numbers of heatwave days and heatwave-attributable deaths by 2,100 (RCP 8.5) (Chaston et al., 2022).

The heat problem caused by these geographical features in Western Sydney is exacerbated by rapid urban expansion, which increases both the probability of heatwaves and the likely severity of impacts on human populations (Khan et al., 2021). Residential development of flat pasture land has reduced the permeability of surfaces to absorb heat and store water (Lawton and Morrison, 2022). Many developments approved in Western Sydney are low-cost peri-urban infill, with small block sizes leaving no room for trees, and houses built very close together. In some areas, there is less than one meter between houses and limited requirements for trees or shade around the home to mitigate the effects of extreme heat (Davis, 2021). Adding to these factors, modern design favors dark roofs and driveways (Lopes et al., 2016) and artificial grass is sometimes used instead of lawn to reduce maintenance costs and water inputs (participant 3.2; Abraham, 2019). As one urban climate academic interviewed for this research noted:

“...we are still building [dwellings that] average ... 250 m² gross floor area, but our block [sizes] have shrunk from 600 to 400 m². That means there is less and less space left where ... you have the chance to introduce some kind of cooling.. Western Sydney developments are doing this hundreds of times in the same space, where previously you had a paddock... it's just heat that you're introducing and you're not allowing air circulation between homes.” (Participant 3.2).

With limited scope for natural cooling from trees and gardens, houses are built to rely on air-conditioning. The heat release from air-conditioning units during high temperatures contributes further to urban overheating (Khan et al., 2021) and increases the public health risk of heatwaves causing, or coinciding with, power outages, which would leave neighborhoods with no access to any heat mitigation features. There is a strong need for planning and interventions to alleviate the impacts of Western Sydney's urban overheating and adapt to future heat events (Khan et al., 2021).

Adapting to the public health challenges of extreme heat in Western Sydney requires actions to reduce the immediate heat-related health risks and prepare the community for regular exposure to heat. This includes a focus on strategies to reduce heat in the urban landscape (Jungman et al., 2023); educate and warn the community concerning extreme heat; and improve conditions for outdoor workers (Mason et al., 2022). The following section examines how well the current legal framework in New South Wales works to promote these adaptation responses.

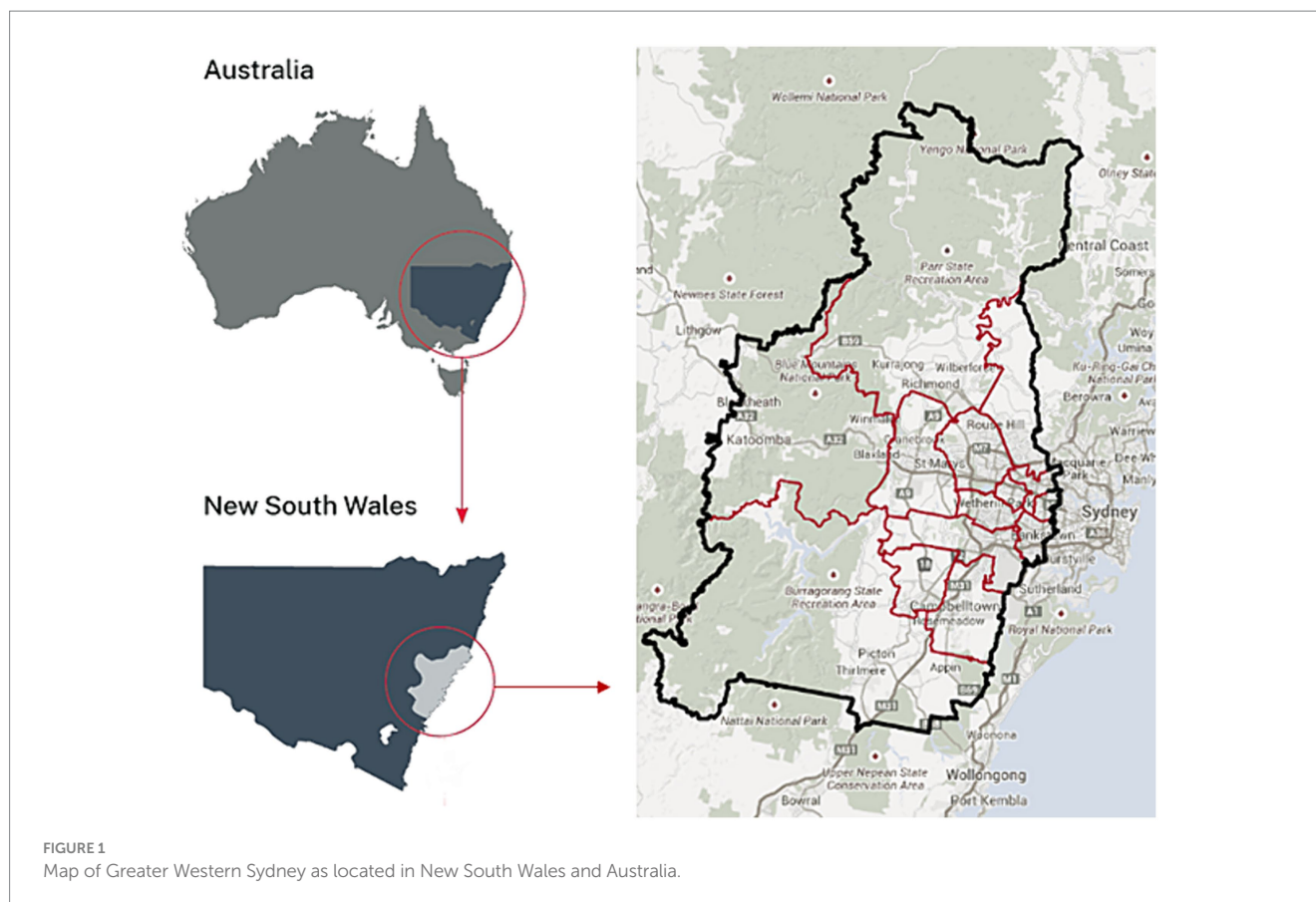
3 Strategies for adapting to extreme heat in Western Sydney

This part introduces four strategies that are critical for helping urban populations adapt to heat extremes. It then examines how laws promote or, more commonly, constrain the implementation of these strategies in Western Sydney. A range of different legislation, regulations, policies and institutions govern the implementation of each strategy, across national, state and local scales, as illustrated in Figure 2.

From the outset, it is noteworthy that heat is not explicitly addressed in any NSW legislation, and none of the laws that might otherwise facilitate adaptation to extreme heat are principally directed to public health protection. This is in contrast to other environmental health impacts, such as water and air quality protection. These are typically addressed directly, including from a public health perspective. There is a diversity of necessary interventions to manage extreme heat including urban planning, emergency management, workplace health and safety and industrial relations. This diversity makes the legal framework governing the management of extreme heat in Western Sydney fragmented and complex (Figure 2).

3.1 Strategic urban planning to minimize heat

The first adaptation strategy for minimizing urban heating is to ensure a long-term approach to urban design for heat. Urban



infrastructure can be designed in ways that prioritize cooling and reduce the impact of heat, while boosting productivity and promoting sustainability (PricewaterhouseCoopers Australia, 2011). Western Sydney will need a combination of urban cooling approaches, including green infrastructure, water sensitive urban design, shading, and cooler building materials (Coutts et al., 2013; Asha and Fallowfield, 2021; Chaston et al., 2022). Other important interventions could include mandating a maximum house size to ensure adequate airflow between properties, and mandating 'lighter roofs, more street trees and nature strips, smaller houses with big, irrigated gardens, triple-glazed windows, and a ban on fake grass' (Participant 3.6). Utility providers will also need to be considered in regulation as they play an important role in securing power supplies, and delivering access to water for irrigation of green spaces such as public gardens, parks and street trees, and cooling transport corridors. Architects and property developers will also need to be empowered, incentivized and – at least in heat sensitive and vulnerable areas such as Western Sydney – obliged, to design suburbs and homes to offer cooling that reduces reliance on air conditioning (PricewaterhouseCoopers Australia, 2011; Lundgren-Kownacki et al., 2018).

The most relevant legal tools for achieving this adaptation strategy are spatial planning instruments, encompassing the policies and laws that guide land development. They include strategic instruments such as zoning regulations or land-use plans and rules governing development approvals. Planning instruments play a key role in shaping the urban environment and can either facilitate urban cooling or, contrarily, exacerbate urban heating. For example, if they are designed to facilitate adaptation, planning instruments can set heat

planning objectives, develop metrics for understanding and measuring heat, help to build a comprehensive base of information on heat risks, and develop a diverse portfolio of heat mitigation and management strategies (Mason et al., 2022). However, poor spatial planning leaves the burden of urban heat management to developers' or individuals' choices about building design and construction.

Some spatial planning instruments applicable to Western Sydney articulate important urban cooling interventions. Their implementation would greatly improve the capacity of Western Sydney neighborhoods to protect public health during heatwaves. The *Environmental Planning and Assessment Act (1979)* (NSW) requires the NSW state planning authority (currently, the Department of Planning, Housing and Infrastructure) to prepare strategic regional planning policies that outline a vision and direction for regional planning and land use (New South Wales Premier and Deputy Premier, 2021). One such policy is Greater Cities Commission Regional Plan managed by the Greater Cities Commission. The Greater Cities Commission is a statutory regional authority responsible for aligning strategic planning across six Sydney regions including Western Sydney (Greater Cities Commission, 2023) and working with local government to align their local planning statements and policies to those regions (Greater Cities Commission Act, 2022, p. 9).

The Greater Cities Commission Regional Plan document sets practical objectives to reduce the impact of heatwaves and extreme heat in urban areas (Greater Cities Commission, 2023). These include increasing urban tree canopy, creating corridors of urban green space, creating new wetlands, increasing irrigation of green space,

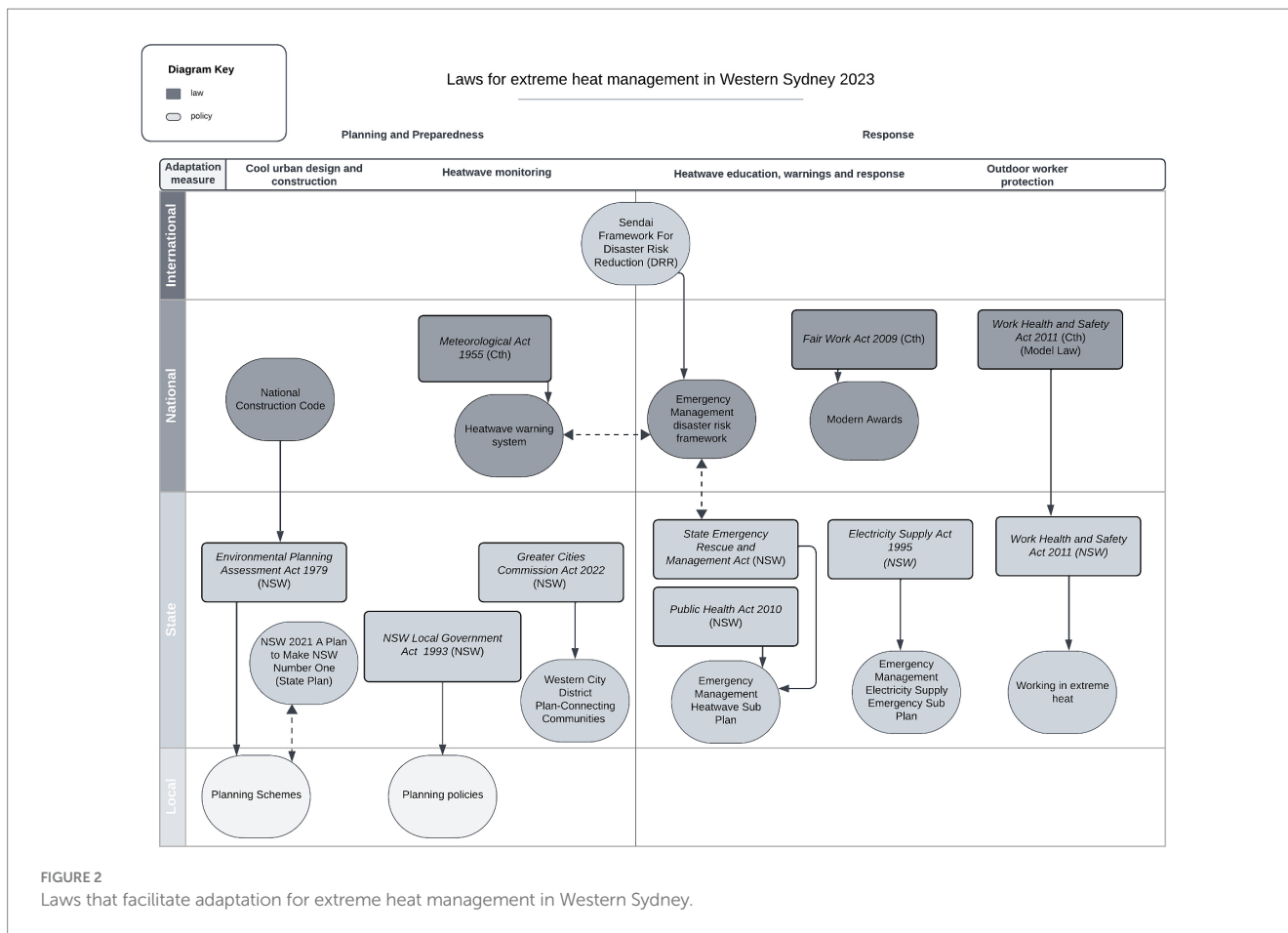


FIGURE 2 Laws that facilitate adaptation for extreme heat management in Western Sydney.

and avoiding urban development and intensification of development in areas exposed to urban hazards (Greater Cities Commission, 2023). Local governments must ‘aim to incorporate’ these objectives when making their own strategic plans and planning statements [Greater Cities Commission Act, 2022 (NSW), s 10 (g); Local Government Act, 1993 (NSW) s 402 (1)], but there are no legal obligations to do so.

Several local governments in Western Sydney incorporate the goals of the Greater Cities Commission’s Regional Plan. For example, Penrith City Council has recently proposed amendments to its Local Environment Plan to preserve and expand green infrastructure such as urban green space and tree canopy; retain water through rainwater harvesting and water reuse; and reduce the need for mechanical ventilation and cooling systems including through passive building design, cooling building materials and passive ventilation (Penrith City Council, 2021). Once the revisions are adopted, these measures will have to be implemented on all land zoned Urban, which includes all high density housing areas within Penrith City [Penrith Local Environmental Plan, 1998 (Urban Land) clause 7; Penrith City Council, 2021].

These multiple planning objectives are helpful, but not enough to ensure rapid, practical change. At present, the planning instruments that apply to development in Western Sydney do not require, mandate, measure or enforce the urban cooling strategies that they ‘aim’ to achieve.

The growing threat of extreme heat in Western Sydney is creating an urgent impetus to implement urban cooling measures, such as the

urban greening and development controls described above, to achieve the goals of the Greater Cities Commission’s Regional Plan. An adaptive public health law approach suggests that implementation must occur at the right scale for effective management (Armstrong and Kamieniecki, 2017, p. 2; Cosens et al., 2017). Identifying the most suitable scale can be difficult and this challenge is amplified in the public health context where some problems do require intervention across multiple scales (Cosens et al., 2017). Nevertheless, focusing on the importance of scale-fit allows us to highlight both specific shortfalls in the approach taken in Western Sydney, and practical opportunities to improve strategic planning for urban heat management.

There is a mismatch between policy priorities across government scales in New South Wales. The New South Wales 2021 State Plan (‘State Plan’) prioritizes housing availability through more high density living in Western Sydney, at the expense of heat mitigation and does not address the issue of urban cooling at all (New South Wales Premier and Deputy Premier and Deputy Premier, 2021, p. 13). Both the Greater Cities Commission objectives and local government efforts are to improve strategic urban heat planning. This mismatch in policy goals undermines adaptation. State planning policies override Local Environmental Plans in the existing legal hierarchy and local governments lack the power to require alterations to existing houses to improve thermal efficiency once they have been built under the state policy guidance. Yet, responsibility for dealing with the problems that this causes rests with local government. Local councils are expected to coordinate and resource heat refuges so people can escape

their hot houses in extreme heat even though they did not create the problem and are the tier of government least able to address it (Dufty, 2022).

While supplying housing to people in need is an important immediate concern in the Australian city with the worst housing shortage, the current housing policy is locking in future heat problems. The effects of housing policies that ignore public health risks such as urban heating impact disproportionately on the most marginalized communities:

“[R]ight now, there's a lot of accessible or affordable housing development going on in Western Sydney. But, unless the state [government] makes changes now, all those developments are really not going to perform to keep people safe from heat into the future” (Participant 3.2).

This risk is especially problematic because, as the research group ‘Sweltering Cities’ has shown, many lower income people in Western Sydney avoid using air conditioning due to cost (Bacon, 2021). Since a higher proportion of people on lower incomes reside in affordable housing built with only air conditioning as a thermal protection, they are at an increased risk from extreme heat.

To promote clearer policy alignment across scales, urban planning must be aligned vertically, from local to regional to state government, with a ‘clear line of sight between strategic priorities’ (NSW Government, 2018, p. 8). The New South Wales Government will need to amend the State Plan to address and support adaptation to climate impacts, particularly urban heat. In addition, coordination of planning policies is essential to guarantee that alignment occurs. For instance, the Greater Cities Commission examines local government strategic planning statements to ensure alignment with its own regional planning objectives. However, it lacks authority to assess or influence state-level policies or plans. This suggests that the vertical coordination function must be performed at the state level unless the Commission’s review powers are expanded.

There is also a ‘horizontal’ mismatch in strategic planning responses across local governments in the Western Sydney region. This means that urban heat planning is inconsistent across contiguous local government areas such as Penrith, Paramatta and Blacktown. For example, the Penrith City Council’s Community Strategic Plan briefly describes urban heat in Penrith. It includes objectives about protecting and enhancing the environment in ecologically sustainable ways, and strengthening climate stability and resilience, but the Strategic Plan does not articulate any concrete actions to achieve those objectives or measures against which to determine success (Penrith City Council, 2022, p. 17, 1.3). Penrith has developed a separate Cooling The City Strategy, which provides examples of actions that the local government can take to mitigate urban heating (Penrith City Council, 2015, pp. 18–20), but this strategy lacks a clear connection to the Community Strategic Plan, any mandate to implement and deliver its ideas, or any clear benchmark for assessing its success. Paramatta City Council’s strategic plan for heat mitigation, by contrast, includes an objective to prepare for key climate hazards, including urban heat, by embedding resilience and climate change adaptation in the city (City of Paramatta, 2022, p. 47). It sets a clear measurable goal to increase vegetation and tree canopy cover in the city to 40 per cent by 2038 and 2050, respectively (City of Paramatta, June 2022, 47). Blacktown City Council’s strategic plan is more like Penrith’s, providing very limited

detail on reducing urban heat, with the only relevant priority in the strategy focusing on heat-resilient development (Blacktown City Council, 2022, p. 19). Blacktown has a separate climate change strategy. It notes the problem of urban heat for the area and the need for urban cooling strategies, but offers no concrete solutions (Blacktown City Council, 2020).

The differences in strategic planning documents across these three local government areas illustrate what happens with a lack of coordinated regional planning for urban heat. The result is an inconsistent approach to a problem that spans the entire Western Sydney region, where prioritizing investment in clear, measurable actions to mitigate urban heat could provide collective benefits. In the absence of state government leadership, local governments in the Western Sydney region could collaborate on prioritizing and investing in heat mitigation strategies. Governed by the same regional strategy, these council areas could develop a consistent, multipartite approach to mitigating urban heating that aligns with state and regional priorities, enhances adaptation ambition, and improves public health outcomes.

3.2 Heat sensitive building design and construction

Alongside landscape-scale strategic spatial planning, an important adaptation strategy for achieving adaptive public health law is to ensure that building construction standards improve thermally-efficient design (March et al., 2021, pp. 12–14). Australia’s National Construction Code (‘Construction Code’) contains nationally-consistent, technical design, construction and performance requirements for building and construction (Australian Building Codes Board, 2022). The Construction Code has been criticized for its ‘general silence’ on heatwaves and, in particular, its failure to adequately consider the performance of buildings during heatwaves (March et al., 2021, p. 18). Most houses are designed to minimize winter energy use by maximizing warmth, rather than providing shading and cooling in summer (March et al., 2021, p. 19). Thermal comfort is addressed in the Construction Code primarily as a question of energy savings. Despite emphasizing the potential energy usage of structures, however, the Construction Code underestimates the amount of energy required to cool a dwelling in summer (Upadhyay et al., 2022, p. 12). As a result, the Construction Code perpetuates the same focus as the state planning scheme, on air conditioning for thermal comfort within individual buildings, rather than emphasizing safety and the contribution that dwellings make to increasing urban heat (March et al., 2021, p. 19). One local government representative observed that the Construction Code:

“conflates thermal comfort with energy efficiency, so it doesn't talk about thermal autonomy or thermal survivability at all. And that's really where we know the shift needs to be. When they test the thermal comfort and the ability for those homes to protect people, they assume air conditioning is running, which we know for vulnerable groups often isn't the case, either because they don't have access, they're renting, or they can't afford the energy bills. And, in that heatwave scenario, we know power outages are big risks. So, thermal safety is important for the general community as well as the vulnerable” (Participant 3.5).

The shortfalls in construction laws for the thermal comfort, autonomy and survivability of new dwellings become particularly pronounced – and particularly harmful for health – when air conditioning is not available. There is no requirement for air conditioning in the National Construction Code. This is a particular problem in summer:

“We also know that the Code doesn’t actually require houses to be built with air conditioning, which makes them even more unsafe. So, we’re advocating for changing that space to have a thermal autonomy, or a thermal safety standard, and basically to test how those homes perform when there is no air conditioning present” (Participant 3.5).

The Construction Code was reviewed in 2022 to require improved residential building efficiency and indoor thermal performance requirements (NSW Department of Planning and Environment, 2022). However, the review did not resolve the problem of thermal safety. It continued to focus on energy efficiency, and thereby perpetuated the existing reliance on air conditioning to meet the new requirements.

The New South Wales Environmental Planning and Assessment Act (1979) [s 6.33(a)] requires that building and land subdivision work comply with the Construction Code through the Building Sustainability Index State Environmental Planning Policy (BASIX SEPP) NSW Government, (2023b). The BASIX SEPP controls building and subdivision design, including shading around a building, roof color and the amount of green space that is required around homes (Asha and Fallowfield, 2021; March et al., 2021). The Sustainable Buildings SEPP operates alongside the BASIX SEPP and requires improved energy efficiency through insulation, double glazed windows, and eaves over windows (The Department of Planning and Environment NSW Government, 2022, p. 6, 12). This makes New South Wales the first Australian state to implement changes in line with the 2022 updates of the National Construction Code that are described above (The Department of Planning and Environment NSW Government, 2023). However, neither the BASIX SEPP nor the Sustainable Buildings SEPP cure the limitations of the Construction Code in not addressing thermal safety. While the benefits of thermal efficiency will also yield benefits for thermal safety in many instances, thermal safety is not expressly protected or guaranteed by this framework.

Public health laws must be responsive to change, to ensure the overall adaptive capacity of public health responses. The Construction Code illustrates problems with a focus on past climatic conditions and a corresponding challenge of slow and reactive law reform. The Code has a built-in three yearly review process that allows for the collection of new information, and opportunity to amend the instrument to account for changing circumstances (Australian Building Codes Board, 2022). In practice, however, those regular reviews have not resulted in changes to the Code in line with the changing climatic context for the thermal performance of housing during heatwaves. The 2022 changes to the Construction Code to require enhanced thermal efficiency failed to consider improvements for heat mitigation (Participants 3.4, 3.5 3.10, 3.11). As one local government participant commented:

“The National Construction Code underwent review in 2022 and it’s as if they didn’t hear anything we’ve said about the risks of

urban heating. I can’t see anything that recognises the contribution of buildings and designs to urban heat. Buildings are a way people can avoid and minimise heat exposure.. But if the power goes and we lose our air conditioning, we could fry instead. ... The Code is literally ignoring our advice concerning future heat” (Participant 3.11).

It is unclear why the 2022 review failed to include comprehensive heat mitigation. It may reflect a problem with the priorities of the reviewers or review process, or a focus in the Code on large scale developments and achieving low costs for builders.

The shortfalls of the Construction Code are made worse by the way in which it is applied by state governments, not as a set of minimum requirements which can (and should) be exceeded by developers, but as an acceptable standard for compliance with limited or no expectation of innovation and ambition, or improvement over time. Standardization through a national code purports to guarantee safe and predictable minimum limits on building design – at least for the risks and climatic conditions that informed the design of the code. However, as the climate changes, that baseline is no longer sufficient to guarantee safety – as demonstrated by the concerns of participants in this project, quoted above. The opportunity for the Construction Code to facilitate adaptation in building design over time is being missed, including because the BASIX SEPP is implemented in Western Sydney not as a starting point for what developers could do for urban cooling, but rather, as a limit for what developers must do, regardless of the growing risks and impacts of urban heat. A participant from local government highlights this missed opportunity:

“Part of the problem is that the National [Construction] Code sets a minimum standard, but then state governments come in and implement them and they are just that, the lowest possible standard.” (Participant 3.5).

In addition to a shortfall in adaptiveness, these limitations in the building standards also represent a potential equity problem because building a more heat-resistant or heat-adapted home is considered ‘above standard’ or a ‘market extra. benefiting only those that can afford it (Participant 3.6).

The Western Sydney Regional Organization of Councils (WSROC) has advocated for a substantial revision of the Construction Code and BASIX SEPP to ensure higher standards are applied to new developments (Participant 3.11). WSROC has proposed a review of all parameters likely to be affected by a changing climate to prioritize stronger energy efficiency and thermal comfort (McAuley et al., 2021, 59). The New South Wales state government had considered promoting more heat-adapted housing through a proposed Design and Place State Environment Planning Framework (Deloitte Access Economics, 2021, p. 1). The central feature of the framework was a Design and Place SEPP, which was intended to promote heat mitigation by restricting the use of black roofs, requiring increasing greenery around homes, expanding block size and reducing house sizes (Deloitte Access Economics, 2021). Despite a lengthy process of consultation, the framework was abandoned when the Planning Minister who had championed the reform was replaced in 2022:

“It was two years of policy reform in the making, to regulate how we build homes and suburbs and neighbourhoods. The

government was in a position to drive important and necessary change in the building industry, but instead the new Minister came along and because they were lobbied, they let it all go” (Participant 3.2).

In the absence of stronger obligations in the National Construction Code, there is a clear need for more specific planning instruments, whether that be a new Design and Place SEPP as proposed in 2021, or some other requirement. The New South Wales government established a new Building Commission NSW at the end of 2023 ([New South Wales Government, 2023](#)) to oversee the building industry and enhance the quality of residential building in the state. It is not yet clear whether the Building Commission will contribute to new climate-adapted building standards such as improving the thermal safety of buildings. While the body has been given responsibility for delivering on state government policies related to housing, its priority is likely to be guided by the State Plan described above, which emphasizes new housing stock rather than improved building design to address urban heating. Meanwhile, houses continue to be built in New South Wales that rely on air conditioning. This places the occupiers at greater risk of future heat stress and other heat-related harms.

The review processes for the National Construction Code and the various New South Wales SEPPs require a more evidence-based, nimble, and less politicized way to capture and respond to climate data, urban research and industry/consumer expectations. One method to accomplish this is by integrating events-based triggers that mandate review of the Code and BASIX SEPP when specified circumstances occur, such as after a certain number of houses are built, or after extreme weather events such as heatwaves. A review trigger could insist on an evaluation of the BASIX SEPP’s capacity to deliver the objectives of the [Environmental Planning and Assessment Act \(1979\)](#) (NSW), such as that set out in section 1.3 to safeguard the health and safety of occupants. Legal amendments could be mandatory if the review revealed deficiencies, and published reasons required from the relevant Minister for any decision not to amend the SEPP after a review. A pre-determined trigger for review contained in the Code and SEPP themselves would help to improve the responsiveness and adaptability of building laws, embedding a mechanism to respond to evolving circumstances, particularly those requiring urgent or innovative solutions.

3.3 Extreme heat education and heatwave warnings in NSW

Given that current planning and construction laws are locking heat into the urban form, the third important strategy for facilitating adaptive public health law is to improve community education and build community capacity to adapt. This strategy is an essential expression of health equity. Health equity refers to the importance of everyone having fair and just opportunities to attain an optimal health status ([Braveman and Gruskin, 2003](#)). It may require differentiated policies to protect vulnerable individual and groups. Health equity is crucial for effective adaptation to urban heat to protect the vulnerable ([Turek-Hankins et al., 2020](#); [IPCC, 2023](#)). Applying health equity in law can help safeguard vulnerable populations and allocate resources according to need. Despite its

importance, the current legal framework in New South Wales fails to recognize or promote health equity. There are no principles or objectives of equity contained in legislation or policy relevant to extreme heat and limited measures to ensure the most vulnerable are educated, warned or protected. Nor is there a single agency or body explicitly entrusted with primary responsibility for identifying and communicating with vulnerable populations.

Community education is especially important for improving health equity for groups that are vulnerable to extreme heat. A recent survey in Sydney demonstrated a lack of knowledge about heat risks, revealing that people ‘feel prepared’ for heatwaves, but many also rely heavily or exclusively on air conditioning in that preparation even though this is potentially maladaptive ([Farbotko and Waite, 2011](#); [Lopes et al., 2016](#); [Hanson-Easey et al., 2019](#); [Gee and Gissing, 2021](#)). There are two key components to promoting health equity and promoting a more adaptive approach to public health community education: (1) ensuring that information is provided through a wide range of actors and media to maximize its reach; and (2) ensuring that warnings are particularly targeted to inform and support vulnerable communities.

Heat communication campaigns must involve a range of actors and media to ensure information reaches everyone in the community in a form they can understand. This will include local news media, the internet, television and billboard advertising campaigns prior to and during heatwave events ([Hanson-Easey et al., 2019](#)). At present, state and national governments play the most substantial role in producing and disseminating heat-related information. Key government actors include the NSW Chief Health Officer, who can provide statutory public health warnings under the Public Health Act 2010 (NSW) if they are of the view that there is a risk to the health or safety of a sector of the public. This is a relatively common practice through government media releases, albeit the extent and frequency of the message dissemination are left to the discretion of media organizations.

The state health department (‘NSW Health’) has responsibility for broader public education under the State Heatwave Subplan of the NSW State Emergency Management Plan ([Emergency and Rescue Management Act \(1989\)](#) (NSW) s 15(e); [New South Wales Government, Office of the NSW State Emergency Services \(2023\)](#), 9–11). NSW Health disseminates heat-related information to the public during and beyond emergency events. The Environmental Health Branch of NSW Health produces health information regarding extreme heat and provides heat health advice to other agencies ([NSW Government, \(2023a\)](#)), in collaboration with a network of state-run District Public Health Units.

The national Bureau of Meteorology (‘BoM’) Heatwave Service plays a crucial information role, providing heatwave assessment forecasting from October–March. The BoM calculates the likelihood and predicted severity of heatwaves (low intensity, severe, extreme) and publishes alerts on its website, BoM phone app, through the media and directly to state and territory partner agencies in the emergency and health sectors ([Australian Government Bureau of Meteorology, 2022](#)). It uses a three-phase warning approach (‘advice, watch and act, ‘emergency’) (Participant 3.10). People are not directly targeted by alerts unless they subscribe to the alert service by text message or email (Participant 3.10). Actually responding to BoM warnings is a state and territory government responsibility, which allows states and territories to apply relevant laws and local knowledge to tailor local responses (Participant 3.10). The BoM’s heatwave service is an attempt to offer an ‘equitable and uniform warning

service to all Australians, no matter where you live, whether you are [in a] capital city, or totally regional or remote' (Participant 3.10). However, while it is geographically 'equitable, it is not currently targeted at informing vulnerable groups.

Producing information and providing public education about extreme heat events is an important protective public health measure, but will only facilitate adaptive public health if the information is timely, adequate and targeted (Kovats and Kristie, 2006, p. 597). Targeted warnings require data on localized climate risk for vulnerable populations, derived from pairing vulnerability information with localized heat data (Pfautsch and Rouillard, 2019). This requires identification of the groups or populations that are especially vulnerable to extreme heat (Campbell et al., 2019). The New South Wales government planning department collects vulnerability data as part of its Heat Vulnerability Index but it lacks sufficient specificity to appropriately target vulnerable groups:

"It is very high level data. It's ... only providing a potential understanding of where the vulnerable communities are, because it's all just data sets overlaid. Some councils know from their own experience that it's not always accurate, a few [councils] are doing their own vulnerability mapping from their own data, and [local] experiences" (Participant 3.5, 2021).

The collection of more localized data about temperatures in a variety of urban areas can be tailored for localized vulnerability planning (Western Sydney Regional Organisation of Councils, 2021, p. 37). The Paramatta and Penrith local governments provide exemplars of useful microscale urban heat data research, that could be extended to other areas. In 2018–19 heat sensors were deployed across Penrith and Paramatta suburbs to collect specific heat benchmark measurements (Pfautsch and Rouillard, 2019; Pfautsch et al., 2020). Using this data, it was possible to identify patterns of variation in air and surface temperature across various microclimates during the summer of December 2019 to January 2020 (Pfautsch et al., 2020, p. 13). Penrith City Council overlaid this data with their existing sociodemographic data and local knowledge, to establish a detailed local vulnerability map (Participant 3.3, 2021; Penrith City Council and Leichhardt Council). This sort of information is invaluable for understanding urban heat and its potential impacts and, if this approach was adopted by other Western Sydney local councils, would support substantial improvements in public health adaptation across the region.

Preparation for heatwaves involves gathering and disseminating information about their impact, as well as educating the community about crucial response options. This includes empowering people to know what to do when air conditioning cuts out above certain temperatures or during power failures (Nairn and Williams, 2018). A comprehensive heat warning system needs clearly-identified vulnerability data, so that it can include direct communication with vulnerable people (Kovats and Hajat, 2008, p. 46). A range of vulnerable groups require additional targeted information including non-English speakers, the elderly, pregnant women, school children, outdoor workers, people at outdoor sporting events, and people with specific health problems (Zottarelli et al., 2021, p. 314). Targeted heat warnings can alert and prompt these groups to take suggested actions. Direct communication needs to include using providers who work

with vulnerable people, making direct contact by phone or email, or even door knocking (Navi et al., 2017, p. 11). For example, medical professionals, pharmacists, schools, workplaces, sporting bodies and religious groups. Information must be coordinated to ensure consistency and safety, but coordination needs to be undertaken in a way that does not limit the capacity of all relevant agents to disseminate it (Hess and Ebi, 2016, p. 24).

No targeted warnings of the kind described above are issued during heat events in Western Sydney and there is no legal responsibility to provide them. Overall, the New South Wales legal framework reveals a problematic lack of accountability for delivering targeted warnings about extreme heat. As one interview participant said, '[N]o one entity is responsible for connecting directly with the vulnerable, so there is no clear requirement or procedure for dissemination of this [target] information.' (participant 3.5). The Greater Cities Commission does not have responsibility as an information or education provider for extreme events such as heatwaves. However, it does play an assurance role, assessing local government planning statements against its own objectives. Therefore the Commission is well-positioned to enhance equity in adaptation planning and responses by, for example, publishing guidance and providing information and other resources to support local councils to provide timely and targeted education, focusing particularly on vulnerable groups. This would be consistent with the Commission's Western Sydney District Plan objectives, which include to ensure people and places adapt to climate change; to reduce exposure to natural hazards; and to manage heatwaves and extreme heat (Greater Cities Commission, 2023, p. 20).

Applying local area expertise, local governments can develop targeted warnings and community education initiatives informed by detailed vulnerability data. The NSW State Heatwave Subplan recommends that local authorities consider doing more than merely distributing information. It recommends that they 'target vulnerable communities, but does not explain what this might involve. (New South Wales Government, Office of the New South Wales Government, Office of the NSW State Emergency Services 2023 2023, 8, 10) Amendments to the State Heatwave Subplan could require local governments to undertake down-scaled vulnerability assessments and provide education campaigns and warnings, with support from the State government. Penrith City Council has shown that this data collection is feasible, although it requires a network of heat sensors and human resources to collect and analyze the data.

New South Wales could also adopt a Vulnerable People in Emergencies Policy akin to the one in place in the state of Victoria (Victorian State Government, Department of Health and Human Services, 2018). The Policy establishes a voluntary vulnerability register for evacuation purposes, but its scope could be extended to include increased support during extreme heat events. The Victorian policy also encourages Victorian government health agency staff to support registered vulnerable clients develop personal emergency plans (Victorian State Government, Department of Health and Human Services, 2018). In Victoria, this policy is funded by service agreements across several state government agencies - the Departments of Emergency Management and Health and the Police service (Victorian State Government, Families Fairness and Housing, 2024).

3.4 Improving conditions for outdoor workers

The final strategy for fostering public health adaptation acknowledges the escalating risks for outdoor workers. Public health literature recognizes the impact of heatwaves and urban heating on employment (International Labour Office, 2018). Temperatures exceeding 26°C are likely to decrease worker's productivity capacity as their health deteriorates (Levi et al., 2018). Estimates suggest that, by 2061, heatwave events could result in the loss of up to 2.7 million working days per year in New South Wales (Melville-rea and Verschuier, 2022, 14 and Table 4). This figure relates to all workers, but outdoor workers are of particular concern (Zander et al., 2015; Melville-rea and Verschuier, 2022). Risks are increasing for workers in the construction industry, postal delivery, community services, gardening, agriculture, lifesaving, armed forces, and police and emergency services. It is more difficult to control these kinds of outdoor work environments, so heat will be increasingly problematic for the productivity and welfare of these outdoor workers (Zander et al., 2015; Xiang et al., 2016). With Western Sydney's urban expansion, construction workers are especially at risk:

“There are folks out there in construction working in 40 degree heat in the middle of the day. Often, they... can't afford to stop working. They have not got a hope in hell of taking a day off because it's too hot” (Participant 3.1).

Workers' Unions and Safe Work Australia raise awareness about outdoor worker safety in the heat (Participant 3.5). Yet participants in this research expressed concern that heat-related deaths will increase before employers in many industries take seriously the need for more protective action (Participant 3.1, 3.10). This concern appears to be driven by a lack of awareness by employers and a high demand for employees to fill positions in many outdoor industries: ‘Too much work and not enough staff often leads employers to cut corners on safety.’ (Participant 3.10). As such, clarifying employer obligations under work health and safety laws in relation to heat, including standards for safe working conditions are important mechanisms for facilitating public health adaptation through law.

To improve conditions for outdoor workers, it is necessary to recognize the risks associated with outdoor working environments and modify work conditions to minimize that risk. Workplace safety standards must require access to cooling, which may include locations to escape the heat, cool water and protective clothing (Morris et al., 2020). Industrial relations laws will also need to accommodate changes in working arrangements in particularly hot conditions. Research from the United States shows that the greatest gains in worker protection from extreme heat come from working with employers to create an enterprise-level heat-safe awareness protocol (McCarthy et al., 2019). Such a workplace protocol is directly linked to reduced workplace compensation claims, due to greater supervisor and worker awareness of the signs and symptoms of heat illness, resulting in earlier intervention (McCarthy et al., 2019).

All workers in Australia are protected by a specific legal regime for workplace health and safety. (The Work Health and Safety Act 2011 (Cth)) Model Law covers the hazards and risks that arise from working in increased heat, even though heat is not expressly mentioned (Safe Work Australia, 2017, p. 5). The model law is enacted in New South

Wales through the (Work Health and Safety Act 2011 (NSW)) and applies the same duties as the Commonwealth model law (Work Health and Safety Act 2011 (NSW) s 16, 17, 19). This means that heat is one of the risks that businesses in New South Wales must consider to protect and reduce risks to employees' health and safety (Work Health and Safety Act 2011 (Cth) s 17; Work Health and Safety Act 2011 (NSW) s 17; Safe Work Australia, 2017, p. 4). The Safe Work Australia model guide for managing the risks of working in heat outlines the duties owed by employers and employees (Safe Work Australia, 2017). A Federal court case involving a soldier in the Australian armed forces who died while on duty in the Australian outback concluded that employers have a duty under the Work Health and Safety Act 2011 to protect and educate their employees against any foreseeable risk of heat illness and take reasonably practical steps to protect their employees from the risk of heat illness (Comcare v Commonwealth of Australia, 2007).

The Common Law is likely to impose duties on employers similar to those under the model law. Employers have been held to owe a ‘duty to take reasonable care to avoid exposing the employees to unreasonable risks of injury’ (High Court of Australia, 1956). Though yet to be tested in the courts, it is likely that this duty will extend to the growing health and safety risks of extreme heat. At present, however, neither statutory workplace heat protection duties nor the Common Law provide detailed guidance to employers about what might be required of them. They do not, for example, clearly define what constitutes an unsafe working temperature or condition.

Industrial relations law can also be used as a mechanism to protect outdoor workers from heat. The Fair Work Act 2009 (Cth) sets out 11 minimum working conditions, the National Employment Standards, that apply to 110 industrial awards covering millions of Australian employees (Fair Work Act 2009 (Cth) s 61). These industrial awards outline the legally enforceable working conditions and can be reviewed as required by the Fair Work Commission. Increasing extremes of weather events in Australia have led to inclement weather being recognized as a specific circumstance where an employee may be stood down with full pay (Fair Work Commission, 2020). Fair Work Australia defines inclement weather as the existence of abnormal climatic conditions where it is unreasonable for an employee to work. The definition includes extreme heat (Fair Work Commission, 2020; Fair Work Ombudsman, 2023).

There is no general legal provision for inclement weather conditions in the National Employment Standards, but such provisions are now contained in some industrial awards that affect outdoor workers during extreme heat (Fair Work Ombudsman, 2023). For example, the Building and Construction General On-Site Award 2020 provides that if an employee considers conditions to be inclement, they can request a conference with the employer (Fair Work Commission, 2020, p. 24.2). If weather is considered inclement, employees must make themselves available for transfer to other work sites or duties or wait on-site for conditions to clear up (Fair Work Commission, 2020, p. 24.2). Importantly, there is no right for employees to leave a site due to hot weather, although the employer may elect to release employees from duty (Fair Work Commission, 2020, p. 24.2). The Building and Construction General On-site Awards only entitle employees to full pay for 32 h of inclement weather in any four-week period (Fair Work Commission, 2020, p. 24.7).

A prolonged heatwave could cause conditions to go beyond 4 days in a four-week period. It may therefore be necessary to vary awards to

create capacity for longer periods of inclement weather leave although employers may find it difficult to justify some extended leave conditions. Promoting flexible work hours [Fair Work Act 2009 (Cth) s 65] may be another solution, such as relaxing the rules around operation of machinery in early mornings to allow an early start, or at the end of the day, to allow evening work when conditions are cooler.

Australia's Fair Work Act 2009 (Cth) also offers the opportunity for some outdoor workers to trade away inclement weather provisions for other benefits in enterprise agreements, such as higher rates of pay [Fair Work Act 2009 (Cth) s 139]. This arrangement could increase pressure on employees to continue working during unsafe hot conditions. Industrial award 'heat limits' could overcome this deficiency (Participant 3.10), including by setting limits requiring workers to stop work beyond a certain air temperature:

“Unless you make it clear that a certain temperature is too hot, then how do those young apprentices’ know to stand up to their boss and say it’s too hot to work today?” (Participant 3.10)

However, specifying maximum temperatures is complex and potentially inflexible because of microclimate and workplace variation:

“When you are standing on a roof in a new development and there is no shade, it is going to be different than when you are working in the botanical gardens sitting on a mower.... How do you differentiate between these various industries?” (Participant 3.1).

This means that heat 'limits' may need to vary within industries covered by the same award. For example, the Building and Construction General On-site Award covers workers in general building and construction, landscaping, traffic management staff, sewage construction workers, and people who work in lifts and cranes (Fair Work Commission, 2020). However, these various workers will have diverse exposure periods, requiring more nuanced legal limits.

Inclement weather conditions can be expanded to cover all outdoor workers' awards. This could occur through a tightening of the provisions in the National Employment Standards to recognize inclement weather and the need for provisions to protect workers from a range of weather conditions. This would require some variation of conditions depending on the industry. To assist with this industry specific protocols can be developed. A protocol like the Construction Forestry Mining and Energy Union Western Australian Branch's 'inclement weather procedure agreement' (Western Australian Branch of the Construction Forestry Mining and Energy Union, 2016) could be considered for New South Wales. Read in conjunction with the 'inclement weather provision' in the industrial award, the protocol requires a minimum standard of health protection to be observed during hot weather (Western Australian Branch of the Construction Forestry Mining and Energy Union, 2016).

Industry-specific heat protocols can be developed through partnerships with unions, industry bodies, and other stakeholders. This enhances their tractability from an adaptive public health law perspective. This is because promoting common responsibility and interest in outdoor worker protection reflects the principle of health solidarity. Safe Work New South Wales already works with industry bodies, unions, and employers to highlight the importance of extreme heat and its legal ramifications. However, the heat information already

available is general, and lacks industry-specific detail (NSW Government Safe Work, 2023).

In New South Wales, use of the State Heatwave Subplan could offer a more adaptive solution that specifies temperature work limits. Activation of the State Heatwave Subplan (or even issuing heatwave warnings) could be written into awards or agreements as the trigger for inclement weather provisions and adjacent policies. Under this strategy the State Heatwave Subplan could mandate obligations to disseminate target warnings and education, and stipulate how this obligation is coordinated between Safe Work New South Wales, NSW Health, the Office of the New South Wales State Emergency Service, and industry bodies.

Safe Work New South Wales could also collaborate with industry bodies to promote education and broader use of inclement weather procedures for awards and agreements. Attention must be given to increasing the education and warnings about heat for outdoor workers and for the whole community. Much of this work can occur within the existing regulatory regime; it simply requires improved coordination and collaboration. However, looking ahead, reforms will be necessary to align national and state responses for improved heat protection across all workplaces. At the state level, the State Emergency and Rescue Management Act (1989) (NSW) could require state agencies to share information and resources to improve protection for outdoor workers and other vulnerable groups from the health effects of extreme heat. This includes Police, Fire Ambulance, Health Care Services, Public Health, Allied Health, Planning, Work Safe, and Justice agencies.

4 Conclusion

For some time now health practitioners have called for health considerations to be mainstreamed in all government policies (Polsky et al., 2015; Van Eyk et al., 2017). Climate change poses health risks that cannot be controlled within a siloed public health sector, so multi-sectoral responses are necessary.

Using extreme heat as an example, this article has highlighted the benefits of assessing and applying the law to promote public health adaptation. The life-threatening impact of extreme heat will continue to rise and requires immediate adaptation efforts around the world. In 2023, for example, the world experienced the highest global temperature in over 100,000 years (Romanello et al., 2023). Countries have an obligation to develop and implement law and policy that protects the right to health (Nampewo et al., 2022) which necessitates measures for public health protection.

This article has shown that existing legal frameworks can improve adaptation to extreme heat in Western Sydney, and New South Wales more broadly, but that the focus of existing public health law is too narrow for the scope and scale of the challenge that extreme heat poses. Multiple, climate-related risks to health are managed by legislation across a range of sectors that may not typically be considered relevant to public health. For example, Australia's Meteorology Act 1955 (Cth) authorizes the national Bureau of Meteorology to record and issue warnings about the weather, but that Act has also become crucial in preventing death, injury and illness from severe weather events associated with climate change.

Existing laws are likely to be able to support the implementation of some public health adaptation responses, but there are currently

many gaps and inefficiencies in the legal framework to promote public health adaptation. In the case of extreme heat, successful long-term adaptation requires increased focus on planning and preparation that facilitates more effective cooling strategies in cities and dense urban areas such as Western Sydney. Urban planning and specific heat mitigation mechanisms require coordination across government scales through a consistent commitment to thermal safety in developments. Regular review of building and development standards need to be based on research and best practice after major extreme events. Laws can be used to expedite the use of heat sensitive designs and improve development processes and protect the community from extreme heat. Greater collaboration is needed across levels of government to coordinate the development and enforcement of heat safe planning and building codes.

Law reform must also ensure a greater focus on health equity to protect vulnerable populations through improved education, warnings and data collection, and promote cross sector protections for outdoor workers. This would include clearer obligations to collect vulnerability data and apply it through targeted warnings and protective measures during heatwave events. Cross-sector collaboration will become even more important as the impacts of climate change increase (Bowen et al., 2013).

Outdoor workers are a high priority for protection through law. Existing workplace duties contained in Australia's Work Safe laws offer useful protection for vulnerable outdoor workers. Industrial law reform and industry-specific protocols would increase awareness of the risks and responses for all outdoor workers in all forms of extreme weather events.

This article has focused specifically on extreme heat, but the issues raised indicate concerning shortfalls in legal capacity that are equally relevant to the full range of climate-related health challenges. A holistic approach to public health adaptation that considers a wide range of laws and collective effects is crucial. In reforming the laws that influence public health under climate change, principles derived from both adaptive governance and public health law can offer valuable guidance. The law must also be made to be flexible enough to seize windows of opportunity to enhance public health adaptation. Laws can contribute to the creation of an enabling environment to facilitate the use of appropriate adaptation actions across a range of impacts that affect public health.

Health equity principles are essential to ensure that the law protects vulnerable populations. This could include law and policy to assist in the collection of meaningful data to drive interventions that reflect how local environments contribute to vulnerability. Laws are also needed to facilitate improved warnings and communications for vulnerable populations across a range of risks. Vulnerability mapping and target warnings require improved coordination to incorporate considerations for multiple extreme weather events including extreme heat, smoke, dust storms or asthma thunderstorms.

In designing health-oriented adaptation laws, it will also be important to avoid maladaptive approaches. For example, water-sensitive designs such as water features or human-made wetlands to mitigate heat in the urban environment, need to be designed and implemented in a way that avoids mosquito breeding which would heighten the risk of infectious diseases. Avoiding maladaptation will create new opportunities for positive synergies in public health adaptation. For example, national governments (through the National Construction Code) and state governments (through state building

and planning laws) could improve building standards for better air circulation, to avoid health impacts from smoke or other pollutants such as dust. State governments could mandate coordinated approaches that integrate vulnerability mapping and targeted warnings by local governments, requiring them to consider multiple extreme weather events in decisions under building and planning laws, including the increasing risks of extreme heat, smoke, dust storms or asthma thunderstorms. State governments could also mandate the integration of vulnerability mapping into planning decisions about, for example, whether to approve a proposed dwelling or subdivision, prioritizing equity to protect vulnerable groups in a way that promotes adaptive public health.

Many human health risks from climate change could be reduced or avoided with 'proactive, timely and effective adaptation responses' (Cissé et al., 2022, p. 1,044). Law is by no means the best way to deliver all public health adaptation responses and there has been limited attention paid globally to the health-adaptation-law nexus. We suggest that the law plays a critical and under-recognized role. We have highlighted where existing laws could promote adaptation if governments applied those laws more effectively and offered some specific ways in which governments can facilitate public health adaptation to extreme heat through law reform. The same opportunities can apply to other impacts on health, many of which are cascading and compounding. By illustrating how existing law can be used to consider and promote adaptation, this paper makes a preliminary contribution, and further research is needed.

Author contributions

JB: Conceptualization, Methodology, Investigation, Writing – original draft, Writing – review & editing. JM: Conceptualization, Methodology, Supervision, Writing – original draft, Writing – review & editing. PM: Conceptualization, Supervision, Writing – original draft, Writing – review & editing.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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