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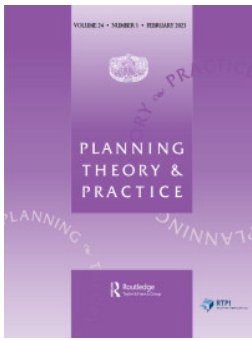
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Critical Heat Studies: Deconstructing Heat Studies for Climate Justice

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ABSTRACT

Emergent planning strategies to address heat-driven health inequities are informed by studies examining how these distributional concerns relate to the urban built environment. Through a critical review, I argue that this ‘heat scholarship’ largely operationalizes heat as a disembodied, depoliticized, and ahistorical entity detached from lived experiences that connect the built environment with people’s health. This paper makes contributions across critical environmental justice scholarship and planning, providing a conceptual and methodological intervention through four ‘Critical Heat Studies’ principles: 1) Social production of heat, 2) Heat as a form of institutionally-sanctioned violence, 3) Intersectionality and heat epistemologies, and 4) Thermal (in)security.

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Introduction

Amidst the climate crisis, environmental, sustainability, and resilience planners are becoming increasingly concerned with urban heat, ways in which heat-related health impacts are exacerbated by the built environment, and what planners can do to curb heat’s deadliness. Supporting emerging heat mitigation practices is a disparate and substantial interdisciplinary body of ‘heat studies’, with contributions from public health, building science, geography, landscape ecology, environmental justice, urban climatology, and other disciplines, which often identify urban management and planning as a site of intervention. These studies have characterized the magnitude of heat as a public health threat (e.g. Zhao et al., 2021), illuminating patterns of thermal inequity in the built environment (e.g. Mitchell & Chakraborty, 2015; Parkinson et al., 2021), and generating a public discourse about these concerns. Scholars and urban practitioners have also identified a need to better connect statistical patterns of urban microclimates and health outcomes with people’s everyday practices and experiences (Hamstead et al., 2020). Yet, there has been little effort to understand the embodied and lived experiences of heat, how such experiences are rooted in intersectional identities, and the power relations which structure heat experience across various thermal landscapes that people inhabit while going about their daily lives.

Drawing on science and technology studies (STS)-based critiques of climate knowledge and an emerging feminist literature on *weathering* in the face of climate change, this paper presents a critical review of contemporary heat studies that inform heat planning practices. Given the

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deficit of discourse on ways in which intersectionality and power relations play out vis-à-vis heat inequities, I articulate principles for a 'Critical Heat Studies' agenda. This agenda applies a Critical Environmental Justice frame (Pellow, 2018) to heat inequity concerns, in order to support richer practices of heat equity planning.

Despite the range of disciplines that have been brought to bear on the problem of urban heat, they largely share a positivist epistemology that relies on meteorological detection in outdoor built environments and which lends itself to technocratic approaches that aim to alter outdoor urban climate conditions as measured by numeric meteorological values. Technologies such as infrared satellite imagery, ambient weather instruments, and micro-urban heat island maps make thermal patterns across the built environment visible at increasingly granular scales. At the same time, by narrowly defining heat as a meteorological state, such technologies have the potential to invisibilize human heat experience and drivers of heat inequity. By drawing on a more pluralist body of environmental and climate justice scholarship, heat studies that inform planning could better address the ways in which people's heat adaptations and struggles are politically structured.

Beyond Distributional Environmental Justice Accounting

First-generation environmental justice research in the U.S. operationalized demographic social difference and distance indicators to determine whether low income and racialized communities were disproportionately at risk of environmental harm. Using county-based spatial enumeration units, the seminal United Church of Christ (1987) study found race to be a more significant factor than socio-economic status in predicting proximity to hazardous waste facilities. Contemporary methods that more precisely locate people's residences and environmental hazards have shown these disparities are even wider than previously known (Bullard et al., 2007). While these and similar studies established important statistical facts about whose residential communities harbor the greatest environmental dangers, a more pluralist environmental justice literature has since drawn upon feminist scholarship to articulate concerns around the conditions of recognition, respect, and fair and inclusive process that are preconditions for and co-constituted by distributional injustices (Schlosberg, 2007; Walker, 2009). Climate justice practices, however, remain oriented around distributional concerns, with less concern for procedural and recognitional justice dimensions (Meerow et al., 2019), let alone ways in which intersectional identities structure climate change experiences.

Before the terms intersectionality and racial capitalism entered popular discourse, Black Marxist journalist and activist Claudia Jones formulated both concepts. Jones (1949) used the term *super-exploitation* to describe multiple forms of oppression that black women in America faced as they were systematically pushed out of factory work and into domestic labor following WWII. Exclusion from factory work meant that black women were not the beneficiaries of legislation that was developing for industrial laborers. Instead, they performed non-unionized domestic labor for white women and – under patriarchal gender relations – the unpaid domestic labor of their own households. Jones argued that one could not understand the oppression of black women without considering their unique status *as a worker, as a woman, and as a person of color*. Each of these statuses alone could be leveraged to create social division for capital exploitation (Melamed, 2011); all three layer upon black women the unique condition of super-exploitation.

Feminist theory has elaborated the ways in which epistemic injustices (e.g. which types of work are counted in labor statistics) are used as tools of oppression that help to maintain the interests of dominant classes. A growing scholarship applies similar critique around how scientific knowledge is silencing marginalized experiences with climate change (Tuana, 2013). In the context of climate planning, Osborne (2015) argues that intersectionality and the related concept of kyriarchy (i.e. the power structures that intersectionality creates) provides a generative framework for planners to consider who has a stake in particular knowledge forms, and how climate epistemologies can be expanded to address positions of people given their mixed identities.

More-than-Meteorological

A well-developed literature grounded in STS problematizes scientific narratives that dominate climate change discourse. Notable among STS climate scholars is the British geographer Mike Hulme (2008) who describes climate change "...simultaneously as a physical transformation and cultural object...", and calls for a re-examination of its origins, which are rooted in "scientific disciplines of the natural sciences and in the institutional process of the Intergovernmental Panel on Climate Change" (p. 2). By globalizing climate, such disciplines and processes, de-culturate what is fundamentally a cultural object. Like other enumerated entities (e.g. citizens, the economy), climate is made into numerical (e.g. carbon dioxide concentration) and indexical (e.g. temperature) representations before the technologies of the state can be deployed (Hulme, 2015). If we understand climate or heat primarily as a statistical object, then the solution set is confined to reducing those statistics (e.g. parts per million, degrees). Such statistical objects enable commodification of the biophysical world as part of accumulation processes that entrench the power of economic elites (Seager, 2009). Meanwhile, climate governance dismisses forms knowledge that are needed to understand everyday adaptive practices and how those practices are negotiated under highly uneven power relations (Bee et al., 2015).

The question then becomes: is climate science an appropriate source of knowledge for climate equity planning and governance? Would more interdisciplinary knowledge enable broader forms of climate justice meaning-making? Hulme (2008) argues that inter-disciplinarity in climate change research has not produced an adequate epistemological framework for climate; rather, the framing of climate change needs to be broadened before considering how to address it. Similarly in the domain of heat governance, there is an urgent need to consider how meaning has been constituted, how that constitution delimits the possibilities for heat governance, and what epistemologies could inform more robust heat equity planning practices.

Intersectionality of Weather Politics

Informed by feminist studies, an epistemological restructuring is emerging around weather and *weathering*. Drawing on ontologies that seek to grammatically, conceptually, and practically reorient weather in the context of climate change, this research emphasizes 1) everyday, embodied experiences with weather, 2) co-productive relationships of bodies (among other materialities), place, and weather, and 3) political-climatological marginalization and resistance. In describing the meanings people attach to weather in coastal regions of British Columbia, Vannini et al. (2012) define *weather* as "an active, reflexive, practical disposition to endure, sense, struggle, manipulate, mature, change, and grow in processes that, over time, implicate the

place-making of one's dwelling" (p. 362). Similar to Hulme's discussion of 'weather-culturalists', Neimanis and Hamilton (2018) highlight a gerund-based meaning of *weathering*: a tactic by which people co-constitute a "weather-world" with nature. Oppermann et al. (2018) draw on social practice theory to examine bodily experiences of heat, how heat is coproduced by the everyday practices of outdoor workers in Australia's monsoon tropics, and how these practices are structured by relations of political economy. Similarly concerned with how power shapes weather relations, Butts and Adams (2020) describe a politics of weather that emerges among residents in the Outer Hebrides of Scotland, who experience a simultaneous sense of place attachment and institutionalized abandonment. As government breaks its social contract with people living on the economic and climatological margins, these residents embrace a "weather contract" that commits them to reciprocal responsibility with nature and empowers them through a shared rejection of modernity.

Importantly, all of these weather portraits transcend more mainstream distributional framings of environmental and climate injustices that examine for whom or where climate burdens are most severe. Instead, studies of weathering are fundamentally relational. They draw on a feminist politics of difference and intersectionality to describe how adaptive and maladaptive practices, agency, powerlessness, and resistance play out in people's everyday embodied and mundane experiences. Privileging marginalized experiences, "... [w]eathering is... between the neo-liberal heroics of resilience and the victim politics of vulnerability – it recommits to the need for an analysis of structural and systemic violence as essential to thinking through life in a changing climate" (Neimanis & Hamilton, 2018, p. 83).

Building on the critical climate science and weathering literatures, I use genealogical inquiry to assert the historical situatedness of heat. Genealogy is a useful methodology for illuminating the historical contingencies of knowledge and discourse, ways in which meaning and power are co-constitutive, as well as pluralist truths and the possibilities they entail (Meadmore et al., 2000). Instead of orienting around linear historical pathways, genealogy emphasizes complexity, contingency, and the fragility of traditional historical narratives (Smart, 1983). In developing a critical review of the scholarship upon which the emerging field of heat planning relies, I unpack the marginalization of everyday lived heat experiences in heat scholarship and heat planning and suggest new modes of inquiry for heat scholars seeking to inform heat planning practice.

In the sections that follow, I first specify ways in which a critical lens can inform heat studies. I then describe ways in which heat's meaning has been constituted by meteorological and hazards mitigation institutions, and show how that meaning influences local-level heat planning. In these sections, illustrative examples are largely drawn from a U.S. context, in which heat planning is rapidly emerging as a new terrain of urban environmental governance. The U.S. has a rich tradition of environmental racism scholarship, much of which focuses on ways in which socio-spatial segregation and built environment-related hazards co-constitute each other. Building on this scholarly tradition, numerous studies have leveraged health, built environment, and demographic data to demonstrate statistical and spatial patterns of distributional urban heat inequities. Thus, U.S. city and national-scale hazards management regimes are appropriate cases in which to examine limitations of scientific and governance practices, though it is important to acknowledge that heat-related planning efforts are happening across the globe and taking on a variety of forms. Using a Critical Environmental Justice lens – which raises issues of intersectionality and takes a skeptical posture toward the state – I conclude with a set of Critical Heat Studies principles which highlight epistemological gaps and suggest future direction. I propose that a reconceptualization from heat-as-meteorological-event (Hamstead & Coseo, 2019) to

heat as “thermal (in)security” can open up new situated, place-based, embodied, and political meanings of heat and bring together diverse claims, stories, practices, ethics, and technologies for addressing heat inequity.

A Critical Perspective on Heat

“How one knows shapes how one governs” (Hulme, 2015, p. 558). What a critical lens brings to heat studies is a framework for reflecting on how heat consciousness is structured by particular scientific and bureaucratic orders, and how those orders delineate the possibilities for heat equity planning. A critical lens directs our attention to historical contingencies and related epistemological lenses that shape heat perception, illuminating factors that can foster or impede practical efforts towards heat equity.

Heat studies operationalize meteorological symbols that have become increasingly sophisticated since their 17th century origins. Our apprehension of heat is shaped by its historical character – the evolution of these symbols and ways in which they have come to pervade everyday technology like thermostats in our homes, or weather radar maps on the nightly news. Heat apprehension is also shaped by the historical character of our perception (Horkheimer, 1989) – that we may privilege the visual or audial over the tactile; that we may privilege the ‘objective’ (e.g. meteorological measures) over the ‘subjective’ (e.g. sensory experience). Measurement concerns in heat studies tend to revolve around interference in the purity of meteorological readings. By contrast, a critical perspective directs our attention to *how heat’s meaning is constructed by temperature* and other meteorological measures. In what ways might meteorology – which populates our narratives of heat with particular types of languages and symbols – obscure political dimensions of heat inequity, even as it reveals patterns of uneven temperature in the built environment? And if the dominant heat languages, heat symbologies, and heat epistemologies are obscuring important facts about heat experience, what role then, should they and other discursive tools play in informing our study of heat and heat planning?

A critical perspective also directs our attention to how practices of urban heat mitigation are structured by urban neoliberalism. Whitehead (2013) points out that “... the neoliberal tendency to govern through numbers – abstract disinterested, fungible forms of knowledge...” engenders a “tendency... to think about instrumental rather than intrinsic goals” (p. 7). For heat planning, the solution set of a problem defined by numeric values of degrees Celsius or degrees Fahrenheit includes strategies to reduce those degrees. However, as older forms of redlining (racialized spatial organization controlled by land use, banking, and real estate institutions) are reincarnated as green gentrification (Anguelovski et al., 2018) and climate and disaster capitalism (Klein, 2018), we would expect replications of heat inequity even through the very climate policies designed to address it. A critical perspective is alert to the conflict that government and powerful actors may co-opt climate policy and heat mitigation for their own ends, but also that a narrow focus on climate action occurring in elite policy circles misses ways in which the privatization of climate policy including heat mitigation is contested (Robin & Broto, 2021), and the broader array of actions that are being taken by a variety of climate actors to construct security in relation to thermal concerns. Heat inequity is an emerging terrain in which urban environmentalism is taking place and which links to claims around the securities of basic needs which are privatized under urban neoliberalism.

Thus, a critical lens suggests several questions with respect to heat inequity. 1) What are the ways in which scientific and bureaucratic practices around measuring and managing heat

inequity might simultaneously be muting it or rendering it illegible? 2) What do various modes of inquiry reveal about thermal (in)security and the variety of thermal experiences and practices? 3) In what ways might heat be a form of institutionally-sanctioned violence, at times disguised as a matter of private concern?

Heat Construction in Meteorological and Hazards Practice

Thermal Measurement

Heat narratives rely on thermometric observations – primarily temperature and humidity, sometimes in conjunction with wind direction, wind speed, pressure, and related measures. These types of observations form the dominant modes of thermal expression for urban planners and designers. For instance, Stone (2019, p. 2) argues that unlike hurricanes, heat is difficult to apprehend, since “temperature is driven by solar and terrestrial radiation, which is invisible to us, while hurricanes are driven by the movement of matter, which we can see”. Here, and in many other instances of thermal discourse, temperature is synonymous with heat. The U.S. Global Change Research Program reports on “temperature-related death and illness” (Sarofim et al., 2016), and numerous studies use similar language (e.g. Gasparrini et al., 2017; Li et al., 2013). Temperature and other meteorological indices are used to track intensity, longevity, and frequency of thermal threats. Yet, the temperature of the earth’s surface or atmosphere does not describe heat. It is only when we apply knowledge of human experience that we can derive meaning about hotness or coldness from temperature. In this sense, technologies that enable us to better apprehend temperature (e.g. satellite imagery that enhances its visibility) are insufficient for apprehending heat.

Radiation is a mechanism of heat transfer, which can be measured using a variety of technologies, including a thermometer which conveys the radiative property of mercury, or an infrared satellite camera, which detects infrared rays – wavelengths longer than those which are in the visible light spectrum (roughly between 700 nanometers to 1 millimeter) – and conveys the radiative property of physical objects on the earth’s surface. The human experience of heat, by contrast, is a feeling driven by numerous conditions (e.g. physiology, physical agency and activity, clothing) beyond what can be instrumentally measured, but which we can readily comprehend through thermoreceptors, memory, sense of place, language, reasoning, and emotion. The reliance on temperature of the air or the earth’s surface, humidity of the air, and other thermometric measures to describe heat and cold disembodies such experiences from people and the situations that are part of human phenomenology and culture.

The instrumental temperature record – consistently collected meteorological observations – began in 17th century England amidst a more than century-long search for ‘fixed points’, which could be used as thermometric benchmarks (Chang, 2004). Schwartz (2017, p. 184–185) argues that this constituted the invention of temperature itself; temperature “is a discursive concept produced approximately three hundred years ago ...” Distinguishing between temperature and heat, “Temperature is... [more] about determining how certain materials respond to energy fluctuation in a controlled environment than about relative warmth”.

Like other forms of western science with deep connections to empire and colonization (Tuana, 2013), meteorological practices were fundamental to colonial enterprises involving marine navigation, agriculture, and mineral resource extraction in climates foreign to western Europeans. “Governing climate... always becomes a project about governing or controlling

things other than the weather: physical environments, ... investment flows" ... and "local communities or colonial societies" (Hulme, 2017, p. 14). In an explicit rejection of thermal embodiment, Luke Howard, "father of meteorology", described the utility of meteorology for marine navigation and agriculture (Howard, 1833).

To mention the differing warmths of day and night, or of the different months of the year, is simply to appeal to the test of feeling. But feeling informs us on these subjects only by a vague comparison with sensations, the memory of which, when they have been some time past, is very imperfect. To confirm, or to correct our judgement, as to the comparative warmth or coldness of different days or seasons, and still more to be able to compare Climates together with accuracy, we must be accustomed to the use of the Thermometer. (Howard, 1833, p. 1)

Although Howard discursively rejected human judgement and feeling, he drew on the weather lore of farmers and mariners—grounded in their cultures, traditions, and lived experiences—to build the science of meteorology. The mid-20th century geographer and meteorologist Gordon Manley— who reconstructed the longest historical temperature record based on thermometer readings from 1659 in a region of the United Kingdom— also took keen interest in how weather and climate formed place-based identities across regions (Endfield, 2011). However, weather narratives have largely abandoned such cultural understandings in favor of producing systematic meteorological observations for military and commerce-related activities.

In America, meteorology became standardized in the 19th century after surgeon generals began keeping journals to trace the influence of weather on disease transmission during times of war (Hume, 1940). During WWI, increasing ranges and apogees of artillery, as well as chemical warfare, depended on predictions of wind and air density (pressure and temperature). Building on these meteorological advancements, today the National Weather Service heat event alert system uses standardized definitions for heat advisory, excessive heat watch, and excessive heat warnings for the entire U.S. These generally rely on a combination of temperature and humidity, sometimes in conjunction with other thermometric measures. Like the National Weather Service's heat index, Canada's Humidex thresholds include humidity to account for heat, and Australia uses universal thresholds based on temperature (Oppermann et al., 2017).

Leveraging systematic meteorological observations collected by national and sometimes more local bureaucracies, heat studies find that thermal health effects are uneven across space, time, social groups, physiology, technology, and climate. For instance, given the same instrumentally-measured temperature, people living in lower latitudes of the U.S. (associated with milder winter weather) are at greater risk to cold-related mortality, and people living in higher latitudes (associated with milder summer weather) are at greater risk to heat-related mortality (Curriero et al., 2002). In some cases, these geographical heat-health relationships may even hold in the case of heat waves, which are not defined according to absolute temperature values, but values (of temperature or heat index) relative to a particular locale's average weather conditions. A study examining a 14-year dataset of mortality across 107 urban communities of the U.S. found that excess mortality rates during heat waves in some northeastern and midwestern urban areas are higher than mortality rates in southern cities (Anderson et al., 2009). Geographically, much of the focus on heat waves has occurred in Europe and the United States, following the European heat wave of 2003 which may have contributed to the deaths of over 70,000 people (Robine et al., 2008). However, new research reveals that temperature dynamics are significantly related to mortality in tropical regions as well, though in Sub-Saharan Africa and East Asia, low temperatures during the cold season appear to be associated with higher fatalities rates than high temperatures during the warm season (Zhao et al., 2021).

Within cities, variation across microclimates is associated with heat-related mortality and morbidity, and low income communities and communities of color are at greater risk of injury or death during heat events (Gronlund et al., 2015; Harlan et al., 2013; Hattis et al., 2012; Hondula et al., 2015; Smargiassi et al., 2009). Since outdoor environments are not entirely reflective of the conditions experienced by most residents as they go about their lives, more recent observational studies have investigated indoor (Quinn et al., 2017; Tsoulou et al., 2020) and individually experienced temperatures (Milà et al., 2020), finding that thermal landscapes people experience can significantly diverge from those measured at outdoor, infrequent fixed-point weather stations used to trigger emergency warnings.

While heat studies operationalizing temperature and other thermal indicators reveal disproportionate impact, they also reveal that impact is not consistent across the same instrumental thermal measures. Thus, thermal measures are limited in their ability to explain the subjectivities they have revealed. While granular technological sensing systems (e.g. Liu et al., 2019) in undetected landscapes (e.g. indoor environments or mobility spaces) may enhance understanding of thermal inequity patterns, we cannot entirely extrapolate heat from temperature or inform effective interventions without experiential context. How and where we measure heat informs how it is managed, and to some extent, dominant measures are a cultural and historical artifact rooted in imperial, military, and commercial practices that require precise predictions to navigate an ocean or evaluate future risk of investment. If we wish to develop a fuller understanding of heat in the context of human health, then thermal knowledge forms should reflect this expanded set of concerns.

Thermal Management

In the U.S., thermal management has been incorporated into environmental management regimes that are largely oriented around governing water and protecting property. The Federal Emergency Management Agency (FEMA) provides hazard mitigation plan guidelines for state and local offices of emergency management; these offices are commonly housed within or in partnership with departments of Homeland Security, and sometimes departments of public works, public safety, planning, and or public health. The stated missions of these bureaucracies generally include language such as: “reduce the vulnerability of people and property” (e.g. Kent County Department of Public Safety, 2015) or “reduce the loss of life and property” (e.g. Virginia Department of Emergency Management, 2018), echoing FEMA’s definition of hazard mitigation, as “any sustained action taken to reduce or eliminate the long-term risk to human life and property from hazards” (44 CFR § 201.6 Local Mitigation Plans, 2013). Mitigation and recovery efforts are largely oriented around absorbing risk associated with real estate and infrastructural investment in coastal areas prone to flooding. For instance, FEMA uses a cost benefit analysis-based approach to determine which homes the government will offer to purchase or repair as part of post-flood buyout programs; its criteria include property value and impact on property tax revenue. In such approaches, “[s]eemingly objective criteria mask subjective value-laden judgments” (Siders, 2019, p. 248) and perpetuate inequities by disproportionately uprooting low income households while repairing homes with higher market value (Shi et al., 2022).

To be clear, hazards plans are not limited to the types of disasters that regularly cause damage to physical infrastructure; they “must include a description of the natural hazards that can affect the jurisdiction(s) in the planning area” (FEMA, 2011, p. 19). FEMA defines a natural hazard as one that is related to a meteorological, environmental, or geological event. Heat (and cold)

events thus fit within this definition and are regularly described in hazards plans, albeit less prominently than other hazard types. However, although plans may identify many different types of hazards, states, tribes, and localities are only eligible to receive disaster relief funding from the federal government once a hazard mitigation plan in compliance with the Stafford Disaster Relief and Emergency Assistance Act has been adopted (42 USC Robert T. Stafford Disaster Relief and Emergency Assistance Act, 2019). This FEMA public assistance can then be made available to “fund the repair, restoration, reconstruction, or replacement of a public facility or infrastructure, which is damaged or destroyed by a disaster” (U.S. FEMA, DHA, 2011). Hazard mitigation funds can also be sought for “sustained measures... [to] reduce personal loss, save lives, and reduce the cost to the nation of responding to and recovering from disasters” (U.S. FEMA, DHA, 2011, p. 4). FEMA instructs hazard mitigation grant funds to be used for limited purposes: acquisition and demolition, relocation of structures, and elevation/floodproofing. Broader health protective measures do not appear in FEMA’s hazard mitigation grant funds guidance. Moreover, the types of physical infrastructural modifications which are indicated in this guidance do not ameliorate the health risks associated with heat.

Where hazards plans do more fully acknowledge heat as a threat – in places where hot weather is more extreme, for example – they traditionally treat health dimensions of thermal events as matters of personal protection that can be remedied via informational campaigns. For instance, the Maricopa County, Arizona Multi-Jurisdictional Hazard Mitigation Plan describes its heat mitigation efforts: “Participate with outside agencies to distribute bottled water and provide education about hazards associated with extreme heat” (Fuller, 2009, p. 401). Such strategies imply that if people are suffering from extreme heat, it is because they have not taken appropriate actions to protect themselves.

In the U.S., multi-hazard mitigation plans can be approved without any type of environmental justice analysis, let alone one that considers the multiple ways in which place and identity put people at differential risk (44 CFR § 201.6 Local Mitigation Plans). While some communities are considering differential impacts, hazards practice has a very limited way of defining subjectivity as ‘social vulnerability’ (generally defined by demographic difference indicators) (e.g. Fuchs et al., 2011; Hughes, 2015; Mitchell & Chakraborty, 2015), without a situated understanding of how those injustice dimensions relate to lived experiences and relations of power.

Apart from the FEMA hazard planning framework, U.S. cities and localities are developing heat mitigation planning efforts which largely aim to modify characteristics of the existing built environment (U.S. EPA, 2019). Much of this activity has taken the form of green infrastructure investments – traditionally used to manage storm water – which are touted as having ‘co-benefits’ that absorb storm water while enhancing other ecosystem services like evapotranspiration for heat mitigation (U.S. FEMA, DHS, 2020). In order to identify where these (largely outdoor biophysical) investments should be made, urban resilience and heat action plans often rely upon numerical indices derived from meteorological and public health mortality data. For instance, in New York City, the first heat equity planning initiative (The City of New York, 2017) relied upon a social vulnerability index that used mortality data in conjunction with satellite-derived surface temperature and tree canopy to develop a composite index that helped the City prioritize street tree planting and other outdoor biophysical modifications. Continuing heat mitigation strategies are similarly informed by micro-climate maps (New York City Council, 2023).

These examples are broadly representative of urban heat governance, which tends to focus more on outdoor built environment solutions than socio-political drivers of heat risk. Across 20 large U.S. and Canadian metropolitan communities, Keith et al. (2019) found that the most

common approaches to mitigating heat are 1) promotion of latent heat flux (e.g. expanding tree canopy), 2) albedo modification (e.g. white roofing), and 3) provision of shade cover (e.g. installing solar panel arrays in parking lots). Reflecting a lack of clarity about whose responsibility it is to manage urban heat, the majority of these planning documents were not framed within existing management domains, and human and social services departments are largely absent from what management frameworks are articulated. Traditional hazards planning at both national and local levels has largely governed through lenses of water, wind, military, commercial investment, and property protection. As heat equity becomes a more prominent urban environmental governance problem arena, there is a need to reconsider what sorts of knowledge forms and governing frames can meet heat-related health challenges.

Principles of Critical Heat Studies

In the foregoing sections, I have characterized the state of heat studies and linked practices of this scholarship to its meteorological origins and to hazards practices. In this section, I will summarize implications – the limitations and possibilities of understanding heat inequity, and propose four principles for guiding Critical Heat Studies. The first two principles flag ways in which heat scholarship and practice obscure justice dimensions of heat, thus limiting the impact of planning interventions. The second two principles suggest new ways of understanding and making meaning around the nature of the heat threat and how it might be governed.

Principle 1: Social Production of Heat

Heat is socially-produced in several respects. First, heat is constructed in the built environment by social, political, and economic processes. Although heat is a deadly threat exacerbated by the way developers and urban designers construct the built environment, we do not treat it as a form of environmental pollution for which development is regulated (Stone, 2005). During processes of development, engineered materials replace living organisms and seal soils. Both processes reduce the role of moisture regulation in cooling. Engineered materials alter the albedo or reflectivity of the land surface. Industrial and transportation activities produce waste heat emissions, as do buildings with air conditioning. All of these factors combine to create differential risk across the urban landscape, at granular neighborhood scales.

Heat studies that have proliferated over the last several years have shown ways in which heat-producing and heat-exacerbating outdoor built environments are coupled with socio-segregation patterns that could be putting people of color and people who are economically constrained at greater risk of heat illness and premature death. Urban microclimate patterns are correlated with redlining maps that served as cartographic guides for racial segregation and disinvestment in non-white communities during the U.S.'s New Deal Era of the last century (Hoffman et al., 2020; Wilson, 2020). Heat in the built environment is one spatial manifestation of the hierarchy fundamental to racial capitalism (Melamed, 2011) and urban political economy.

Secondly, heat is constructed discursively as an objective meteorological fact. In other words, at the same time that heat studies are revealing patterns of inequity, they are also disembodimenting its meaning. While spatial mapping and statistical analyses which operationalize social difference indices draw attention to differential health vulnerabilities, they also reduce the politics of heat to a numeric value. Like the science of climate change – which disembodies climate from its cultural meanings and casts it as an apolitical technocratic problem (Bee et al., 2015; Hulme,

2008; Seager, 2009) – the literature on heat inequity similarly reduces a form of environmental injustice to numeric values. When we define heat inequity as the overlay of numeric indices (e.g. average neighborhood-level degrees Celsius and racial proportion), then solutions to address it are also confined to minimizing a numeric value. Yet, as the literature on weathering indicates (Neimanis & Hamilton, 2018), heat experience is structured by conjoined political, economic, and climatological marginalization. Because numeric indices do not capture the embodied and political experiences of marginalized (e.g. colonized, racialized) people, they cannot fully capture how such conjoined threats manifest as thermal suffering and even premature heat-related death.

Principle 2: Heat as a Form of Institutionally-Sanctioned Violence

By reframing heat from a meteorological event to a form of institutionally-sanctioned violence, we can explore its inscription processes in several ways. First, we can examine ways in which the political economic order and relations of power structure health inequities. Second, we become alert that heat policy (e.g. urban heat mitigation strategies) is a subset of climate planning practice happening within a neoliberal context; it thus presents new opportunities for accumulation by dispossession.

In the context of neoliberalism, the public/private dichotomy helps to define the role of planning when it comes to climate, health, environment, and related concerns. Relational dichotomies are leveraged to define what is of individual concern versus what is of community concern, and what is private versus what is public. As critical legal scholars have argued, boundaries across autonomy/community or private/public, are indeterminate, cultivate alienation, and undermine actual freedom while engaging in a rhetoric of liberation (Cook, 1990; Dalton, 1987). Neoliberal freedom narratives obscure the violence that occurs when individuals are left to fend for themselves in systems of commodified housing and commodified energy via socially-constrived roles.

Amidst the problems generated by privatization of the public sphere under neoliberalism, in cities across the U.S., Australia, and the U.K., Peter Brand (2007) argues that “... the environment emerged as an arena in which social welfare could, to some degree or another, be discursively constructed and materially produced at a minimum public cost compared to say job creation, housing or health service provision”. Within this broader environmental management context, heat planning practices are oriented around enhancing outdoor and public environments. For instance, heat refuges can take the form of public parks, public libraries, and public community centers. Yet, such public heat relief spaces can be subject to racialized practices of exclusion, both because communities of color have experienced historical neighborhood disinvestment in such infrastructure, and due to racialized policing of public spaces (Pellow, 2016).

Moreover, *thermal experiences* do not only happen in public spaces but also in spaces that we may consider to be personal or private (e.g. Quinn et al., 2017; Tsoulou et al., 2020). *Heat politics* that structure those experiences arise in ‘private’ or quasi-private relations – the contractual relation between landlord and tenant, energy provider and customer, or employee and wage laborer – beyond the boundaries typically delimited for urban planning and design under neoliberalism.

The environmental domain in which planners intervene can also exacerbate the problems associated with other domains such as housing and energy.

...green and resilient city orthodoxy... that integrates nature-driven solutions into urban sustainability policy... either overlooks or minimizes negative impacts for socially vulnerable residents while selling a new urban brand of green and environmentally resilient 21st-century city to investors, real estate developers, and new sustainability-class residents. (Anguelovski et al., 2019)

Like other forms of green, ecological, and climate gentrification, heat mitigation strategies that improve neighborhood and housing quality can also lead to displacement as property values rise. Housing and energy poverty not only have an immediate impact upon people's thermal environment. They also generate longer-term impact on housing stability, as the cost of home weatherization can get passed on to renters or can increase property values, and lead to higher housing cost. Therefore, a commitment to climate equity implies interventions in relations of power that play out in domains of housing, energy, and labor, and the racial exclusions entailed therein. A central organizing question for climate equity planners – and for which there will be a multitude of culturally-situated and place-based answers – is: how do relations and identities structure climate security and insecurity?

Principle 3: Intersectionality and Heat Epistemologies

Heat studies largely do not consider how experiences of the built environment – constructed around assumed (racialized, gendered, able-bodied) subjects – vary across different identities and intersectional burdens. Physiologically and behaviorally, different bodies (those of children, elderly, people with mobility constraints, people with particular thermal acclimatizations, women who are pregnant) experience heat in different ways. Responsibilities of child and elder caregiving, or occupational hazards associated with agricultural labor, construction labor, or food service labor relate to different experiences with heat risk. Race, gender, class, ability, sexual orientation, and occupational status all combine to structure heat experience in the context of superexploitation. Yet, heat studies and practices of urban planning largely ignore lived experience-based knowledge that illuminates the co-constitution of risk and identity. In an *Interface* piece on Climate Justice in this journal, Blanche Verlie writes: “My sense is that urban planning is still dominated by a vision of itself as dispassionate designers and managers – but not embodied citizens – of urban space ... where human bodies can be ‘in’ the world, but not ‘of’ it ...” (Porter et al., 2020).

In Critical Legal Scholarship, counter-storytelling has been an important methodology for understanding racial discrimination from victims' perspectives and lived experiences, since racism and other forms of discrimination cannot be understood from a position of pure objectivity, detached from life situation (Freeman, 1978) and historically-specific culture or group association (Kennedy, 1990). Epistemological sources of victim perspectives are located in “the actual experience, history, culture, and intellectual traditions of people of color in America” (Matsuda, 1983, p. 63). By contrast with techno-scientific knowledge and governance, intersectional approaches pay attention to the everyday mundane and routine activities that illuminate how power, responsibility, and action are associated with differently and unequally situated bodies (Bee et al., 2015).

Similar to Oppermann et al. (2017) study of utility workers who engage in skillful practices to avoid “going tropo” in Australia's monsoon tropics, there have been community-based efforts to reveal people's unseen thermal struggles. Through the Harlem Heat Project (Vant-Hull et al., 2018), West Harlem Action (WE ACT) for Environmental Justice in Harlem, New York, and ISeeChange, based in New Orleans, catalogued heat experiences among public housing

residents during indoor heat waves, highlighting the barriers that people face when they try to take agency over their own thermal security.

Counter-stories can reveal what happens in the spaces that escape meteorological detection, spaces we may consider to be private, personal, or beyond the purview of public policy. They can ground the meaning of a poverty statistic or thermal index in everyday experiences of power relations between a landlord and tenant, utility provider and customer, bureaucracy and benefit recipient, or employer and wage-laborer. They can illuminate ways in which poverty and marginalization intersect with occupational and caregiving responsibilities, and the survival strategies of people who experience intersectional burdens. They can reveal contradictions between political discourse and reality on the ground.

Although intersectionality is not a mainstream urban governance frame, intersectional climate justice is articulated in the literature, and emerging climate initiatives in Barcelona demonstrate the adoption of an explicitly ecofeminist lens that recognizes the value of care work, domestic labor, and reproductive functions (Amorim-Maia et al., 2022). As methodologies such as ethnography that generate information about people's lived and embodied experiences are gaining traction in urban planning discourse (Mattila et al., 2022), such place-based stories provide insight for co-produced climate policy that incorporates culture, values, subjectivity, and emotion alongside nature, facts, objectivity, and reason (Corburn, 2009).

Principle 4: Thermal (in)security

Thermal (in)security draws on the United Nations Development Programme's notion of *human security*, which extended the meaning of security beyond state-centricity and a privileging of the military domain, to one concerned with overall security of individuals (UNDP, 1994). In the context of climate change, a focus on human security implicates political elites who maintain structurally – as opposed to spectacularly – violent institutions. Thermal insecurity is shaped by atmosphere, built environment, and political struggles. It may manifest as a direct health impact in the form of heat stroke, sun stroke, or hyperthermia. Or it may impact people indirectly as they make tradeoffs across medical, nutritional, housing, and energy needs.

Although energy security, housing security, and food security have been widely defined, thermal security as a normative goal has not been articulated in public policy discourse. It remains disconnected from other health and human service interventions. Urban climate planners are focusing on heat mitigation in the outdoor built environment – in public parks, along street-scapes, on buildings roofs. But public sector efforts to address thermal insecurity also need to address ways in which health risk is relationally structured in sectors of housing, energy, labor, health, and human services.

Heat Knowledge & Practice

How we understand and manage thermal concerns is defined by the epistemology and language of heat. Positivist approaches which address inter-temporal and inter-spatial uncertainty about how weather and climate affect military and imperial, colonial, and other investment-based enterprises (Tuana, 2013) also dominate the field of urban heat studies, where human health and wellbeing are central concerns. The question then becomes, to what extent and in what ways does the objective heat language: dew point temperature, apparent temperature, relative humidity, heat index, mean radiant temperature also map onto health impacts?

Studies which operationalize objective meteorological measures in order to understand health impacts have exposed the subjectivity of heat – that their relation with temperature varies by material conditions, by physiology, and across space and time (Madrigano et al., 2015; Mitchell & Chakraborty, 2015) – but without investigating the meaning of that subjectivity. Now, the field’s dominant epistemology may be reaching its limits with respect to understanding social justice dimensions of heat.

Reframing problems of heat around notions of thermal (in)security and heat politics alter the solution set for climate policy actors. Whereas *heat-as-meteorological event* implies a numeric optimization strategy, *thermal insecurity* suggests interventions in relations of power. It is beyond the scope of this paper to enumerate all of the place-based practical implications that such a reframing entails, but I wish to highlight several critical categories of intervention. For one, a mapping of power relations *vis-à-vis* thermal insecurity can shift planners’ perception of who should bear responsibility for the heat inequities. To the extent that city and national-level strategies attempt to address behavioral dimensions of heat, they tend to be oriented around informing people – especially those considered ‘vulnerable’ – about the risks that they face (Casanueva et al., 2019; Kotharkar & Ghosh, 2022; Lowe et al., 2011). To be sure, there are ways in which people – especially new migrants unaccustomed to particular weather conditions – may benefit from heat-health messaging campaigns. Yet, the literature on weathering suggests that by and large, people are highly attuned to the forces that threaten their health. When the weather is health-threatening, then people become attuned to the weather (Oppermann et al., 2018). Thus, heat inequity may be more a function of who has agency over adaptive practices, particularly in occupational settings controlled by an employer or residential settings in which a renter cannot control their energy system or energy efficiency infrastructure. These power relations suggest a need to strengthen thermal protection regulations against those who do have agency in such settings, and target messaging toward the ‘perpetrators’ (and not only ‘victims’) of thermal insecurity. Second, a thermal (in)security lens also suggests that unintended consequences including racialized displacement are likely to result from heat mitigation and other climate safe infrastructure. This is especially a threat in the U.S. and other countries where racially-exclusionary real estate practices – combined with local governments’ reliance on real estate-based tax revenue (National Conference of State Legislatures, 2004) – have created sharp economic divides. Therefore, strategies to strengthen renter protections, decommodify housing and energy, and otherwise protect against displacement must be central to climate equity governance (Oscilowicz et al., 2021). By way of example, the Transformative Climate Communities program in California which funds climate resilience projects in environmental justice communities requires that grant recipients develop a displacement avoidance strategy (California Strategic Growth Council, 2019). Heat equity planning should consider who has power and agency over the heat-producing built environment, and who stands to gain from various types of heat mitigation interventions. In sum, a Critical Heat Studies lens suggests climate equity practices that simultaneously look at heat experience and to the underlying kyriarchy that structures that experience.

Conclusions

Thermal apprehension is a product of historical processes; it is formed by scientific, bureaucratic, and cultural practices, which define the language of heat, its relation to public and private spheres, as well as appropriate societal responses. Heat studies privilege ways of knowing that involve meteorological symbols designed to support practices of national defense and

commerce – predicting risk of infrastructural investments in coastal areas prone to heavy wind and precipitation, for example. Hazards bureaucracies engaging in such practices rely on scientific objectivity and the production of universal meteorological symbols that disembody heat. The universal quality of these symbols and the practices which they inform can mask subjectivities that define thermal experiences, how those experiences are rooted in intersectional identities, and the power relations which structure them.

With increasing concerns about global warming and the instability of local climates and weather, heat studies are in a transitional phase that has opened up new possibilities for meaning-making and governance. Although flooding may be the ‘primary trauma’ (Radkau, 2002) around which contemporary hazards practices were developed, recent record-breaking heat waves in parts of Asia and the Middle East (Hassan & Peltier, 2020), North America (Caruk, 2021; Masters, 2021; Nelis, 2021), and Europe (Pianigiani, 2021; Philip et al., 2021) – driving electrical shortages, spawning violent demonstrations, leading to crop failure, and exacerbating wildfires – may be generating a new type of environmental terror that could dominate our environmental consciousness. How planners understand and deal with that terror will be defined in part by epistemologies of heat. Over the last decades, heat scholarship has raised awareness that thermal threats present substantial and inequitable public health impacts, and has influenced new heat mitigation strategies that are becoming part of urban planning practice. Yet, an over-reliance on positivist inquiry is stymying the field’s ability to generate new knowledge about the environmental justice dimensions of heat and thus inform a broader suite of measures connected to domains across social determinants of health.

This paper drew from heat scholarship across multiple disciplines, meteorological practices, and hazards practices at various levels of governance. Using a critical lens, I historically situated urban planning practices around heat, and considered ways in which heat relates to political and economic power. Building on recent scholarship on critical environmental justice, I proposed a Critical Heat Studies agenda that seeks to extend the vocabulary of heat planning beyond an abstract symbol, to make meaning around heat embodiment, thermal insecurity, and to emphasize a politics of heat.

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