



Beyond Extreme: Heat Emergency and Water Insecurity for People Experiencing Houselessness in Phoenix, Arizona, USA During the Heatwave of 2023

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Accepted: 12 September 2023 / Published online: 20 September 2023

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Abstract

The U.S. National Weather Service issues extreme heat warnings at 105 °F. The desert city of Phoenix, AZ, in the Southwest USA, regularly exceeds temperatures of 105° between May and September. Yet, there is no word beyond “extreme” to describe these temperatures. Many residents of Metro Phoenix (including 24 municipalities and 5 + million people) have adapted to extreme heat by managing indoor temperatures using air conditioning, including low-cost and energy-efficient water-based evaporative (“swamp”) coolers. The City of Phoenix implemented its first Heat Response Plan in 2022. However, record-breaking heat in 2023 disrupted long-standing heat and water management adaptations, and exacerbated existing heat vulnerabilities and water insecurities with disproportionate negative impacts on the growing population of people experiencing houselessness in Metro Phoenix. Beginning in late June, Phoenix experienced a record 31 consecutive days of temperatures over 110°. The average high in July was 114.7° and the average low was 90.8°. We build upon and update the findings of our earlier study of the experiences of unsheltered individuals and communities in Phoenix between 2013 and 2016 (Palta et al., 2016).

Editor’s Note

In 2016, M. Palta and colleagues published an acclaimed and, as it turns out, prescient article in this journal. Given its timely nature, as evidenced in urban areas worldwide experiencing extreme heat and accompanying water issues, I invited the authors to update their findings and recommendations.

Daniel Bates
Editor

Introduction

Our initial research on ecosystem services and disservices for vulnerable populations in Phoenix, AZ, USA (Palta et al., 2016) used data collected through participant observation, interviews, photography, water quality sampling and testing, and other mixed-methods for socio-ecological research. Our results demonstrated that, for a subset of people experiencing houselessness¹ in Phoenix, access to the Salt River provided key benefits, including bathing, shelter,

All temperatures reported are in Fahrenheit.

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¹ In our original paper (Palta et al., 2016) we referred to our population of interest as people experiencing homelessness. In this paper, we adopt the terms “unsheltered,” “people experiencing houselessness,” and “unhoused” to refer to this population. While there is no widely agreed upon terminology, many activists have suggested moving away from the term “homeless” or “homelessness” due to stigma and perceptions of deviance and dangerousness attached to the term. Additionally, the term “homelessness” implies that a person is without a home, a very personal perception. Many people who live without traditional housing do consider themselves to have a home, even if that home is a tent encampment, a vehicle, or a specific location they typically use.

and cooling. As they accessed these services, however, people in this community were also being exposed to dangerously high levels of *E. coli*, which can cause significant gastrointestinal illness.

The Phoenix metro area experiences the urban heat island effect, a process wherein loss of green space (which allows for evapotranspiration and cooling) combined with dense urbanization, traps heat in cities (Dahl et al., 2019, EPA 2021). In addition, climatological data indicated that extreme heat in Phoenix would get worse because of climate change (IPCC, 2013, 2019). As early as 2002, Baker and colleagues reported that the number of “misery” hours per day (hours per day where the Temperature-Humidity Index is > 100) had doubled from 1948, and that the number of misery days was also increasing. National Public Radio reported data collected by the Maricopa County Department of Public Health that indicated the rate of hospitalizations due to heatstroke and burns had increased substantially from the previous year (Maricopa County 2023a, b, c, and d; Simon, 2023) and that the heat was so excessive that simply leaving an air-conditioned building could pose a serious health hazard.

Sufficient drinking water prevents the effects of dehydration that can result from exposure to extreme heat. Lack of access to water in such circumstances can lead to physical and psychological harm, including cellular damage, cognitive impairments, and negative impacts on cardiac health (Rhue et al., 2023; Rosinger, 2023). Ecosystem services such as water evaporation and plant evapotranspiration provide a cooling effect and regulate the degree of heat exposure for people but require both water and sufficient vegetation. We explore how lack of access to housing and water in conditions of extreme heat combine to create a potentially deadly scenario for many people experiencing homelessness in Metro Phoenix that, despite the 2021 creation of a City of Phoenix Office of Heat Response and Mitigation and the resulting implementation of the City’s first Heat Response Plan in 2022, has worsened since our original article in 2016.

Updates: Warming Climate and Heat Stress

Arizona Extreme Heat Conditions, 2023

According to the Arizona State Climate Office (2023) and the National Weather Service (2023), Phoenix set the record for the hottest month on record in July 2023, including a new record high minimum temperature of 97°, 17 days with a daily high of 115° or higher, and three consecutive days of temperatures at 119°. The overall average temperature in Phoenix for the month was 102.7° (National Weather

Service), and for a record 31 days, temperatures were 110° or higher. Overall, Phoenix tied or broke 12 daily high temperature records, and 16 daily warm-low records (National Weather Service). These conditions have significant health consequences for many, including exacerbating underlying conditions such as asthma, kidney disease, and heart disease (Dahl et al., 2019). While the sheer volume of days with record-breaking heat is remarkable in itself, in combination with drought they create dangerous conditions and significant challenges for people experiencing homelessness and low-income individuals and communities.

Cooling Strategies for Arizona Heat Waves

It has been noted that “nearly everyone in Arizona has air-conditioning,” (Baker et al., 2002) and that 95% of people with access to housing in Phoenix have air conditioning (Larsen et al., 2023). This does not reflect the reality of many low-income individuals and communities in Metro Phoenix and Arizona more broadly. Energy costs, air conditioner age and maintenance, and air conditioner type (e.g., evaporative coolers) may limit the efficacy of air conditioning units to cool air to safe temperatures. And, for unhoused individuals, access to air conditioning and water is predicated on access to libraries, public transit, shops, and city and county-funded cooling shelters (Meehan et al., 2023). As a result of extreme temperatures and the high cost of air conditioning, many unsheltered and otherwise vulnerable individuals in Phoenix seek relief from the heat in shaded public spaces, including riverbeds and parks (Jenerette et al., 2011). However, tree canopy and associated cooling, along with water features and other amenities, are simply not present in many under-resourced neighborhoods (Bausch et al., 2021; Harlan et al., 2006, 2013; Napieralski et al., 2022). As Watkins and colleagues (2021) note, access to a working vehicle can be a significant mediating factor for harmful heat-related outcomes—but this is predicated on access that not everyone has (Avelar Portillo, 2021).

Heat Illness & Heat Deaths Among People Experiencing Homelessness

People experiencing either sheltered or unsheltered homelessness are particularly vulnerable to heat-related illnesses, including heat exhaustion, heat stroke, and dehydration. Homeless people are hospitalized with burns from asphalt heated to 160° + with increasing frequency; in 2022, seven people died from such burns (Partlow, 2023). Scalding has also been reported among people who attempt to access water from outdoor hoses (Partlow, 2023). Exposure to extreme heat exacerbates underlying or pre-existing conditions (Dahl et al., 2019). As Hondula et al. (2021) note,

time spent outdoors is one of the best predictors of heat-related illness, and people experiencing houselessness often have little control over the length of time they spend outside. Research on school-based heat relief plans in Phoenix reports that low-income children, including those experiencing houselessness, are at particular risk for heat stress and heat illness due to the amount of time spent outdoors or in insufficiently cooled indoor environments (Shortridge et al., 2022).

Maricopa County has been recording heat-associated illnesses and deaths since 2006. In 2022, the county identified 435 heat-associated deaths, a 25% increase from 2021 (Maricopa County Department of Public Health 2022). Individuals known to be experiencing houselessness accounted for 40% of those deaths, and people whose living situation was unknown accounted for a further 24%. The extreme heat of 2023 is expected to result in an increase in the number of heat-associated deaths. At the end of July, the Arizona Department of Health Services reported 2,558 emergency department visits for heat-related illnesses, including 712 during the week of July 16 alone, a record high number of visits and almost twice as many recorded during the highest week in 2021 (Arizona Department of Health Services, 2023). Circle the City, the largest provider of healthcare to people experiencing houselessness in Maricopa County reported to Reuters (2023) that their mobile clinic saw an increase in third degree burns caused from clients falling asleep on concrete, as well as severe cases of dehydration. As of Aug. 16, 2023, 89 heat deaths in Phoenix have been confirmed, and another 349 deaths are under investigation (Cervantes, 2023). About 140 of these deaths occurred in the week of July 16 alone. If these numbers are confirmed, this would be the deadliest week ever recorded for heat-related deaths in Phoenix. Based on current data, 2023 is on track to be the deadliest year for heat deaths in Phoenix history (Cervantes, 2023).

Green Infrastructures as Cooling Centers for People Experiencing Houselessness

Green infrastructure—trees, grass, and other plants—provides heat regulation benefits and can mitigate the adverse effects of extreme heat. Implementation of further green infrastructure is a common consideration in Tempe and Metro Phoenix more broadly, including near the Salt River, to mitigate the effects heat and flooding. While extreme heat has not been a driving factor for increasing green infrastructure in the past (Meerow et al., 2021), new efforts to adopt green infrastructure to mitigate heat are now underway as part of the City of Phoenix's Heat Mitigation and Tree and Shade Master Plan, including the Phoenix Tree Bank, Tree Donation Portal, Citizen Forester Program, and Urban

Forest advocacy (City of Phoenix Office of Heat Response and Mitigation, 2023). These projects are generally regarded as beneficial for provisioning, regulating, and cultural ecosystem services (du Bray et al., 2019, 2022).

Updates: Worsening Drought & Water Insecurity

Arizona Drought Conditions, 2023

Arizona has been experiencing an ongoing, long-term drought that started around 1994 (Arizona State Climate Office). Although a wet monsoon season in 2022 and a wet winter season in 2023 helped to improve drought conditions, this drought is considered the longest in the 110 years of record-keeping history (City of Phoenix) and has impacted all sources of water in the Phoenix area, including the necessary levels of surface water in rivers like the Salt River and other above-ground flows.

The National Weather Service has predicted a drier than normal 2023 monsoon season for Phoenix. While the monsoon season typically runs from June 15 to September 15, as of August 4, 2023, no measurable precipitation had been recorded at the official measurement location at Sky Harbor Airport since March 22. This represents the third longest stretch of no measurable precipitation in Phoenix's recorded history (Graves, 2023). In addition to the concerns over long- and short-term drought impacts on water access, the lack of precipitation also results in less heat regulation occurs in accidental wetlands and across the city.

Since 2016, attention has been drawn to the lack of access to water globally, especially among people experiencing houselessness (Meehan et al. 2020, Meehan et al., 2023). Meehan and colleagues' (2023) comprehensive review demonstrates that people experiencing houselessness often experience water insecurity as a matter of state design, including criminalizing camping, closing off public spaces that include water access, and refusing to maintain public spaces. The landscape of water access for people experiencing houselessness has changed very little since our 2016 study, and the urgency of water access and the adverse consequences of its absence were greatly heightened by the COVID-19 pandemic (Staddon et al., 2020; Stoler et al., 2020).

Barriers to Water Access for People Experiencing Houselessness

For people experiencing houselessness water is often extremely difficult to access in public spaces, especially from taps and water fountains in bathrooms and shelters

(DeMyers et al., 2017; Gamble, 2023). While such publicly available water is seemingly more accessible than bottled water, respondents described concerns about hygiene and safety when trying to access water in public spaces. Water sources in businesses, such as fast-food restaurants and convenience stores, are often denied to people experiencing homelessness. Uss (2019) and Avelar Portillo (2021) both indicate that many respondents experience feeling institutionalized or imprisoned when accessing water in a shelter environment, a significant deterrent to using bathrooms, showers, and laundry facilities. As Verbyla et al. (2021) note, even when facilities are clean and acceptable to respondents, distrust of authorities often prevents them from using these facilities.

In Metro Phoenix, access to bottled water is often limited, especially for people experiencing homelessness (DeMyers et al., 2017). While the Maricopa Association of Governments and the City of Phoenix coordinate distribution of bottled water during extreme heat events, they often have only two bottles (2,500 mL bottles, or 1 L total) per person (DeMyers et al., 2017). During an extreme heat event, people need 1–2 L of water *per hour* (ArizonaCare Network 2023) to stay hydrated, leaving aside bathing or cooking needs. The respondents in Gamble's (2023) study reflect those of DeMyers and colleagues (2017), indicating a preference for bottled water for its apparent safety, but note that accessibility and cost represent significant barriers for them.

Riverbeds & Wetlands as Cooling Centers for People Experiencing Houselessness

Our earlier research reported that people experiencing homelessness use rivers, surface water, accidental wetlands, and ephemeral streams for a variety of ecosystem services (Palta et al., 2016), including heat mitigation and access to water for consumption and bathing. Consequently, particularly those with the skills and equipment (e.g., tents, survival skills) are attracted the Salt River's riverbed and the shore of Tempe Town Lake, a 225-acre artificial lake built along the Salt River, where accidental wetlands are present during monsoon season and other times of high water. In addition to access to water, our respondents also pointed out that riverbeds provide other amenities, including shade from vegetation and bridges, heat regulation, refuge from authorities, among others (see also Flanigan & Welsh, 2020).

However, this access is not without hazards: respondents in Goodling's (2020) study explained that they are aware of potential water contamination issues and have been served citations for camping in riverbeds. Water in rain barrels or other containers of attracts algae and bacteria on the surface especially during extreme heat events that can lead to

significant harmful health outcomes if consumed (Goodling, 2020).

Risks of Worsening Water Quality in Ephemeral Streams

As of 2020, the Clean Water Act (CWA) no longer includes ephemeral streams. This means that the sections of the Salt River that are not constantly flowing do not have to meet the standards of the CWA, nor do they require the same level of monitoring (Handler et al., 2022) for pollutants and fecal coliform that pose a threat to human health (Calderón-Villareal et al. 2022; Flanigan & Welsh, 2020; Goodling, 2020; Verbyla et al., 2021). The Arizona Department of Environmental Quality annual water quality report states that as of March 2022, there were no concerns regarding *E. coli* along the Salt River. It is worth noting, however, that the updated data were collected in June 2021, before the monsoon season began. If water quality data were collected in the ephemeral sections of Salt River, the water level would have been very low, meaning that these counts would be very low compared to monsoon season, when we measured water quality (ADEQ 2022). In addition to exposure to high levels of *E. coli*, people experiencing unsheltered homelessness and residing in the Salt River may be experiencing the effects of historical environmental injustice throughout the Phoenix valley since much of the region includes potential brownfields and exposure to the hazardous waste that are a legacy of the region's historical focus on industry (Avondale, 2023; Bolin et al., 2002; Goodling, 2020).

Water quality sampling in nearby regions (San Diego, CA and Tijuana, Mexico) indicates that water quality levels are often unsafe for people using waterways for water provisioning for drinking, bathing, and potentially cooking (Calderón-Villareal et al. 2022; Verbyla et al., 2021). In both cases, people experiencing homelessness, including those who are experiencing state-sanctioned violence and statelessness (Calderón-Villareal et al. 2022), who utilize waterways for provisioning and regulating ecosystem services are often aware of the risks, including exposure to *E. coli* and fecal coliform, but have few alternatives for water provisioning.

Updates: Houselessness

Arizona Houselessness Conditions, 2023

As part of the U.S. Department of Housing and Urban Development's (HUD) Annual Homeless Assessment Report (AHAR), the Maricopa Regional Continuum of Care Board conducts an annual count of people experiencing

houselessness each January² (Maricopa Association of Governments (MAG) 2023a). In 2023, this Point-in-Time (PIT) Homeless Count recorded 9,642 people experiencing houselessness, with 49% sheltered and 51% unsheltered. This is a 7% increase over the 2022 count and a 72% increase from 2017. Additionally, the “chronically homeless” count increased 17% from 2022 and has increased 103% since 2017 (MAG 2023b). While the PIT counts are an important means of collecting data about who is experiencing houselessness and why, all indications are that this method undercounts the number of people experiencing houselessness (Flaming & Burns, 2017; MAG 2023a).

As we noted in 2016, some people experiencing houselessness make the choice to remain unsheltered for a range of reasons. For some, it is the lack of beds: Maricopa County has approximately 4700 shelter beds for people experiencing houselessness according to the City of Phoenix (City of Phoenix, 2023b; personal communication). Additionally, Maricopa County does not coordinate entry into emergency shelters, which means that individuals seeking shelter cannot access information about overall bed availability, but must contact each shelter independently to determine which have open beds and what requirements must be met. For others, seeking shelter is not the goal; they may have the skillset needed to stay out of shelters. Others report that poor experiences with shelter staff, a sense of autonomy and dignity, and sobriety requirements swayed their willingness to engage with shelters (Flanigan & Welsh, 2020; Hughes, 2021; MAG 2023a; Uss 2019). For those who remain unsheltered, the Maricopa Association of Governments Heat Relief Network offers hydration and cooling stations located throughout the county. In 2023, over 200 locations were in operation.

COVID-19: Social Distancing & Pandemic Policies

The COVID-19 pandemic impacted several aspects of the houselessness situation in the Phoenix area. Prior to COVID-19 emerging in 2020, many residents of Metro Phoenix were already in economically precarious situations that impacted their housing (Schlinkert et al., 2020). In the 2023 PIT Count, 247 unsheltered individuals (5.03% of unsheltered total) indicated that their houselessness was a result of the COVID-19 pandemic (Maricopa Association of Governments, 2023a). A moratorium on evictions from March 2020 to August 2021 perhaps prevented this number from being higher, although due to caveats, almost 30,000 evictions were nevertheless filed during that period. Since

the eviction moratorium ended the number of people facing eviction and houselessness has inevitably increased.

During the height of the COVID-19 pandemic, indoor shelter spaces were limited due to social distancing guidelines. In 2020, the Human Services Campus was able to house fewer than two-thirds of the number of people that it housed in 2019 (Boehm, 2020). To comply with the Center for Disease Control’s recommendation of spacing out encampments, the City of Phoenix provided fenced parking lots where 12 × 12 ft spaces were marked off and water and sanitation access were provided. However, these spaces could accommodate only approximately 200 of the over 3,000 unsheltered people in Phoenix and those who were allocated spaces reported issues with heat due to the black asphalt and lack of shade (Boehm, 2020). When combined with the extreme heat of the summer months, particularly in July 2020, COVID-19 proved yet one more challenge for an already vulnerable population.

There has been no systematic analysis of the impact of the COVID-19 pandemic on water access amongst those experiencing houselessness in Phoenix. However, research among a similar population in Portland showed restricted access due to “shut-offs, building closures, and shelter-in-place policies” (Gamble, 2023). DeMyers et al. (2017) found that preferred water sources for those experiencing houselessness in Phoenix were water fountains, public bathrooms, stored water, private water, and non-profit water sources. Phoenix lacks water fountains and bathrooms that are independent of buildings, which suggests that water access was severely restricted for those experiencing houselessness during the COVID-19 pandemic (Meehan et al., 2023). Additionally, lack of handwashing facilities and other water access likely increased the spread of COVID-19 (Staddon et al., 2020; Stoler et al., 2020).

Housing Removal of Encampments

The largest encampment of people experiencing houselessness in Phoenix known as “the Zone,” an area of approximately 0.13 mi², was estimated to have a population of 1,000 people in early 2023. The Zone is in the Capitol Mall District, near the state capital and just outside the Human Services Campus. The area has been a major congregation area for people experiencing houselessness since the 1970s, following the demolition of the skid row neighborhood called the Deuce (Bernstein, 1972). The development of a major shelter facility (Central Arizona Shelter Services (CASS), built in 1984, was replaced in 2005 by the Human Services Campus, a 13-acre property where multiple organizations collaborate to provide services to those experiencing

² The annual point in time count was not conducted in 2021 due to the COVID-19 pandemic.

³ The Zone is a fluid and changing area in this part of Phoenix; as a result, this number is an estimate.

houselessness (Hennigan and Spear 2019; Sanchez, 2022). These service locations have faced opposition from businesses and residents in the area. In August 2022, business owners and residents sued the City of Phoenix claiming that the city failed to prevent crime, loitering, and blocked sidewalks in the Zone. In March 2023, the Superior Court of Arizona found in *Brown et al. vs. City of Phoenix*, that the Zone qualified as a “public nuisance” and ruled that the City must develop a plan to clean up and regulate the area to remove people experiencing houselessness (Superior Court of Arizona, Maricopa County 2023). The plan was released in April and the first “clean-up” began in May. While such clean-ups have occurred in the past, the new ones differ in that the court ruling requires the city to continue to keep the area clear. This presents a unique challenge for unhoused people, as vital public services are centered in this area, including publicly accessible toilets and showers, cooling facilities, legal services, assistance in obtaining IDs, clothing closets, hot meals, a mail room, and medical and mental health services.

Sweeps of the Zone continued through the historic heat-wave in Phoenix. There are no official reports on the number of people who have been removed from the area but news reports (Bennet et al., 2023; Rihl & Rummel, 2023) indicate that around 30 people have been moved from each of the four blocks cleared as of July 2023; approximately 79–86% of people presented accepting shelter or other services⁴. We anticipate that displacement caused by these sweeps encourages people to move to riverine environments like the Salt River where they can access some ecosystem services, although no data are currently available to confirm this.

Other cities in Metro Phoenix are making efforts to forcibly remove encampments of people experiencing houselessness. Our previous study included data from respondents living in the Salt River’s riverbed in Tempe, which provided water, shade cover, and cooling. In the summer of 2022, the City of Tempe began clearing encampments from an approximately 70-acre section of the Salt River, issuing trespassing citations to those who remained. According to estimates from the City authorities and activist groups, somewhere between 20 and 200 people were displaced (Kmack 2023). The removal of the Salt River encampment is linked to increasing flood risks, although perspectives on this vary. Houseless residents say that they are being intentionally “flooded out” by authorities that control the floodgates for the Tempe Town Lake reservoir along the Salt River.

⁴ This number does not include people who voluntarily left the Zone before clean-up efforts began.

Conclusion and Recommendations

Extreme heat in Phoenix (and globally) has intensified since 2016 at the same time the number of people experiencing houselessness and unsheltered houselessness has been increasing. In the context of water access for this population, which is largely unchanged since the publication of our 2016 research, their degree of vulnerability has increased. As state-sponsored sweeps of encampments of people experiencing houselessness have become common in Metro Phoenix and across the United States, resources have become more difficult for them to access, particularly in times of extreme temperatures. While many of our recommendations from 2016 unfortunately remain unimplemented, we can expand on four crucial areas based on ongoing research:

More Effective Coordination and Planning for People Experiencing Houselessness

The City of Phoenix still retains funds allocated through the CARES Act of 2020 to address impacts of the COVID-19 pandemic. It is critical that the City, and Maricopa County more broadly, consider allocating this money toward building infrastructure to facilitate access for people experiencing houselessness to currently available services and to improve and expand the quantity and quality of those services. Availability of and access to shelters that are safe, adequately equipped, and comfortable for people experiencing houselessness are basic to mitigating their vulnerability, particularly to extremes of both heat and cold (see Schlunkert et al., 2020).

There are also significant flaws in strategies for preventing people from losing housing in the first place. Phoenix has been experiencing an ongoing and increasing housing crisis due to a variety of factors including a slowdown in housing construction following the Great Recession (approximately 2007–2010⁵) alongside an influx of population, a wage-inflation disparity, and an increase in investor purchases that deplete the already low housing stock. There are many proposed solutions to address the housing crisis, including rent stabilization efforts (Arizona currently has a statewide ban that prevents counties and cities from implementing rent control (Arizona Revised Statutes Sects. 33-1329 and 33-1416), easing zoning restrictions (many cities zone around 50% of their land for single-family dwellings, which limits construction of multi-family buildings) as well as programs such as tax breaks, subsidies, and expedited permitting (Tziganuk et al., 2022). The termination close of

⁵ Although much of the U.S. began experiencing economic recovery around 2010, between 2011 and 2020, the downturn in housing construction in Phoenix only generated approximately 240,000 new housing units (FSL, 2023).

pandemic-related rental and utility assistance programs is also problematic, and efforts should be made to identify long-term funding solutions for these programs.

Heat Action Planning

The development of the City of Phoenix Office of Heat Response and Mitigation and the Office's Heat Mitigation Plan have led to significant progress towards improved heat mitigation strategies, including 100+ cooling centers in Metro Phoenix, emergency utility assistance, new shade structures, bottled water distribution, the Cool Callers program to check on vulnerable people, the We're Cool volunteer education program to reduce heat-related illness, public pools and splashpads, outreach to schools, and community engagement with people who are heat vulnerable and/or experiencing houselessness. The establishment of the first city-level heat response team in the U.S. is a good start, but many, including within the Office itself, agree with Guardaro (2023), who argues that more planning and coordination with and around people who experience heat vulnerability is necessary. While many people in Phoenix have access to air conditioning (Bausch et al., 2021; Larsen et al., 2023), there are tradeoffs for many—especially people on low or fixed incomes—who need to use it during extreme heat. The high cost, particularly when older or poorly-maintained units cannot provide effective cooling, can be a barrier to use or can be traded against the costs of other necessities such as food (Wright et al. 2020). More and continued heat action planning could ensure that community engagement reaches people with low incomes making these decisions, as well as people experiencing houselessness. While communication with authorities is often avoided and distrusted by people experiencing houselessness (Verbyla et al., 2021), undertaking compassionate, coordinated, and culturally appropriate communication can improve health and vulnerability outcomes (Guardaro et al., 2020). In the longer term, development of fine-grained metrics that track the experiences of people with low incomes and experiencing houselessness (including children)—beyond hospitalizations and deaths—can monitor the ongoing efficacy of Phoenix's heat action plan.

Green Infrastructure and Changes to the Salt River

Increasing the amount of green urban infrastructure has the potential to benefit not just people experiencing houselessness, but the entire city of Phoenix. During monsoon storms, Phoenix often experiences flooding; lacking robust storm-water infrastructure, green infrastructure could help manage these high-water flows (Meerow et al., 2021). Further, increasing green infrastructure, especially in places offering

services for people experiencing houselessness, and other underserved regions of Maricopa County, would increase the amount of shade and heat regulation publicly available. These projects are not insignificant, nor are they without controversy; however, in a city that regularly experiences beyond “extreme” summer temperatures, these steps can mitigate the heat vulnerability of many in the region. This may prove particularly challenging in the face temperatures that caused even plants that are adapted to desert heat, such as saguaros, to wilt during the summer of 2023 (Salgado, 2023). Nevertheless, given the benefits of green infrastructure, attempts to increase water infiltration and shade would prove beneficial (Harlan et al., 2006, 2013; Jenerette et al., 2011). The City of Phoenix Office of Heat Response and Mitigation's current efforts, including the Tree and Shade Master Plan, Phoenix Tree Bank, Tree Donation Portal, Citizen Forester Program, and Urban Forest advocacy should be closely monitored for efficacy, scale-up, and transfer to other areas with heat vulnerability.

Water Access and Equity

While access to safe and cool spaces is of utmost importance, access to adequate water, particularly potable water, is a basic requirement for people experiencing houselessness. Given that bottled water is often considered the safest and most desirable choice, (DeMyers et al., 2017; Gamble, 2023), investing in filters and other sources of “safe” water would be a significant point of intervention for shelters and other areas serving vulnerable community members. Further, in keeping with Sorensen et al. (2021) recommendations regarding water equity, we suggest the development of community water systems, particularly in areas with a high number of people experiencing houselessness. As with heat action plans, building culturally relevant community partnerships among non-profits and other organizations is also crucial to ensuring water access and managing water insecurity in a long-term and meaningful fashion (Sorensen et al., 2021).

Given the implications of Schlinkert and colleagues' findings (2021) regarding housing security, we also suggest that water rates be managed to prevent rate hikes, and that water shutoffs be prevented in times of extreme heat. The City of Phoenix's Emergency Rental Assistance (ERA) Program that provided subsidies for assistance with utility bills and its Eviction Assistance Line that helped to prevent evictions exhausted their funding as of July 2023 (City of Phoenix, 2023c). As Sorensen et al. (2021) demonstrate, maintaining household water access requires a minimum of four hours work at minimum wage (\$13.85 in Arizona) to provide for a family of four. Given the increased use of water during extreme heat and the need for water in hydration, cooling,

and use of evaporative coolers (a low-cost, energy-efficient form of cooling), the financial precarity of many households may be a significant barrier to heat mitigation and water security.

These recommendations are certainly not the only possible solutions to alleviate the vulnerability of people experiencing houselessness, particularly during periods of extreme heat, nor are they comprehensive in their scope and metrics. Nevertheless, they present a range of possibilities that can be explored and adapted for other cities in North America and other parts of the world experiencing similar conditions.

Acknowledgements Thank Dr. Chelsie Romulo and Dr. Jessica Salo for their input on the title of this paper.

Author Contributions M. and R. Stotts wrote the main manuscript text, R. Southee contributed text and knowledge to the section on houselessness, and A.W. contributed text and organized the paper. All authors reviewed the manuscript.

Funding R. Wutich's work on this paper was supported under National Science Foundation Grant/Award Numbers: GCR-2021147 (Action for Water Equity) and BCS-1759972 (Household Water InSecurity Experiences HWISE-RCN).

Data Availability No datasets were used in the publication of this work.

Declarations

Ethical Approval Ethical approval was required for this work.

Competing Interests The authors declare no competing interests.

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