Duke NICHOLAS INSTITUTE for ENERGY, ENVIRONMENT & SUSTAINABILITY

Defining Extreme Heat as a Hazard

A Review of Current State Hazard Mitigation Plans

Jordan Clark and Ashley Ward

Defining Extreme Heat as a Hazard

A Review of Current State Hazard Mitigation Plans

CONTENTS

Abstract

US states must have a Federal Emergency Management Agency–approved state hazard mitigation plan (SHMP) to apply for certain nonemergency disaster funds and funding for mitigation projects. SHMPs identify the hazards that may impact a state and detail corresponding mitigation strategies. This report assesses the treatment and definition of heat as a hazard in each state's most recent plan. The importance of extreme heat—the leading cause of weather-related death in the United States—is often understated because it does not fit easily into current SHMP guidelines. The authors provide recommendations to help states adequately evaluate the threat of extreme heat as they update their SHMPs.

EXECUTIVE SUMMARY

Defining Extreme Heat as a Hazard

Heat is the leading cause of weather-related death in the United States, yet it is often overlooked in comparison to other more tangible events such as severe storms. To have access to certain nonemergency disaster funds, each state must have a Federal Emergency Management Agency (FEMA)–approved state hazard mitigation plan (SHMP). **Many states are in the process of updating their plans; however, a review of these hazard mitigation plans as they currently exist reveals the challenge that states face in adequately incorporating heat as a hazard.** This report assesses the treatment and definition of heat as a hazard in each state's plan. We use a scoring system developed by the Natural Resources Defense Council (NRDC), which recently released an assessment of the southeastern states' mitigation plans (Constible 2022). Many points of discussion and recommendations included here are required in the latest FEMA guidance for plan development, which went into effect on April 19, 2023 (FEMA 2023b). This document is intended to serve as supplemental information and a roadmap, specifically as it relates to adequately framing the hazard of heat. The key takeaways and recommendations aim to support future modernization of the existing processes for risk identification and mitigation planning, an inherently monumental undertaking.

Learnings from Assessment of Existing State Hazard Mitigation Frameworks

- **The importance of extreme heat is often understated in SHMPs because it is combined with other hazards.** Half of the states in this assessment (25) had a dedicated section for extreme heat. Only 12 states had one or more heat-specific mitigation plan(s).
- **FEMA guidance for SHMPs would be strengthened by further modernization of existing processes for risk identification.** The latest FEMA guidelines emphasize hazards as discrete events; however, heat is often subtle and chronic. Requirements for hazard-specific mitigation efforts provide few incentives for states to include heat as a hazard when mitigation strategies are uncertain or funding sources are difficult to identify.
- **The risk assessment of heat relative to other hazards is less robust within current SHMPs because climate change is not adequately incorporated.** States in this assessment often considered projected changes of only one metric (e.g., maximum temperature) and did not clearly link the projected changes with the probability of extreme heat.

Recommendations

- **Establish a state-specific, standardized definition of extreme heat.** Use robust climate data to develop a state-specific definition of extreme heat that accounts for variations in temperature and heat-related illness rates across regions within the state.
- **Account for variations in the vulnerability of different groups of people environmentally exposed to extreme heat.** Consider hazard-specific variations in vulnerability between groups of people, understanding that who is vulnerable and how they are vulnerable likely varies across different types of hazards.

- **Adequately incorporate climate change into assessments for extreme heat. Incorporate multiple metrics to capture changes in climate.** For example, use maximum temperature along with other variables, such as minimum temperature and humidity, to understand the complexity of extreme heat in a changing climate. Combine these metrics with projected population changes (e.g., age distribution) to frame the future trajectory of heat hazards in a specific state.
- **Develop appropriate mitigation and resilience strategies for extreme heat based on recommendations from states throughout the region and community stakeholder engagement.** Involve experts and community stakeholders in the development process to ensure sustainable and realistic mitigation and resilience strategies for extreme heat. These include climatologists, public health experts, and community stakeholders such as planners, faith-based leaders, agricultural extension agents, athletic trainers, etc.

INTRODUCTION

Over the last 30 years, heat exposure has killed more people in the United States than any other weather-related event (NWS 2021). It has killed almost twice as many people as floods, and as many as tornadoes, cold weather, and hurricanes combined. Extreme heat is also a hazard we are certain will become worse in the coming decades as a direct result of climate change. However, despite the Biden administration's recent attention to policies to expand worker protections related to heat exposure (through the Occupational Safety and Health Administration [OSHA]) and improve access to household cooling (through the Low Income Home Energy Assistance Program [LIHEAP]), the US has lagged behind the rest of the world in both recognizing heat as the hazard it is and in organizing the necessary resources and capacity to address it (The White House 2021, Office of Community Services 2023).

Heat isn't as apparent to the human senses as the visible destruction caused by hurricanes, floods, or tornadoes. The view outside looks the same at 85°F as it does at 105°F. The economic consequences of the widespread property damage caused by hurricanes, floods, and tornadoes are impossible to ignore. But if we combine the economic impact of labor loss, hospital visits, and agricultural losses, along with the health impacts of heat exposure, extreme heat is among the most devastating consequences of climate change and, unfortunately, the most ignored (Parsons et al. 2022; Schmeltz et al. 2016; Munch 2022).

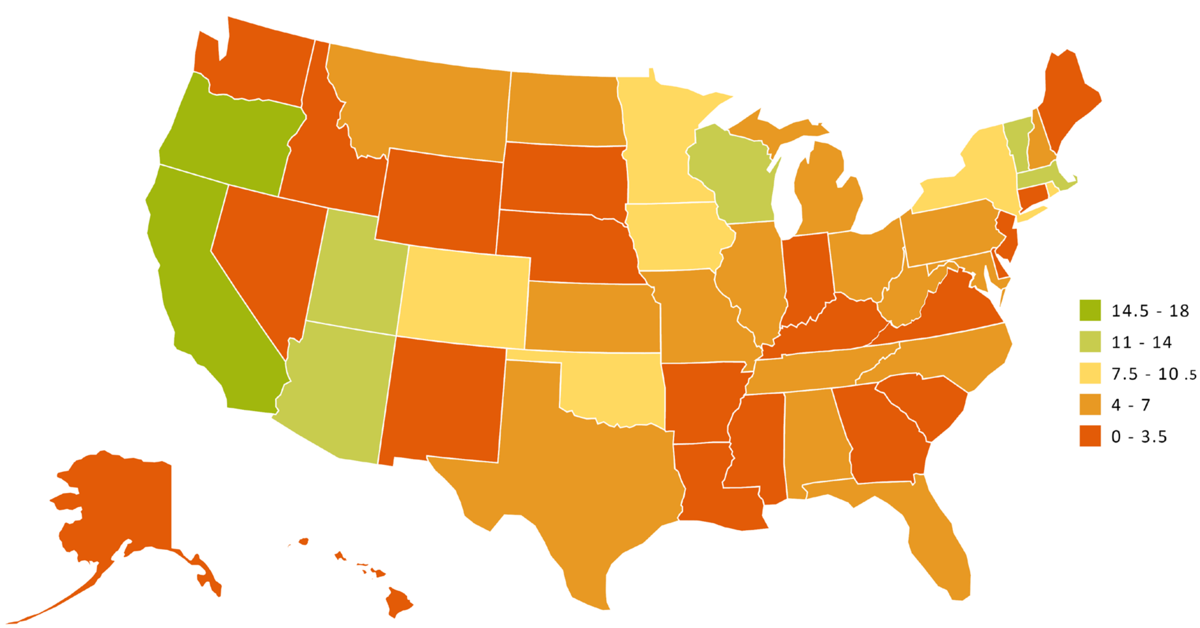
SHMPs are designed to reduce the threat to human life and the risk of property damage. These plans are the basis for states' preparation for natural hazards in the immediate future and long-term efforts to mitigate these hazards. Additionally, a FEMA-approved SHMP is required for states to be eligible for certain emergency funds and grants (e.g., Hazard Mitigation Grant Program [HMGP], Building Resilient Infrastructure and Communities [BRIC], Fire Management Assistance Grant. Localities also submit hazard mitigation plans to FEMA, for which the SHMP is intended to serve as guidance. Thus, the importance of adequately classifying hazards at the state level is paramount.

We assessed SHMPs based on a scoring system developed by the NRDC, which recently released an assessment of the SHMPs from each state in the southeastern United States (Constible 2022). The goal of this report is to conduct a similar assessment, covering the entire United States, to better understand how extreme heat is incorporated in SHMPs and to provide recommendations to improve the process and outcome of planning activities for extreme heat. This scoring system assessed the treatment of heat within each state's mitigation plan, considering both the overall risk assessment and the detailed heat-specific mitigation strategies. Specifically, this scoring emphasized the following factors:

- Inclusion of a dedicated risk assessment section for extreme heat
- Identification of geographic areas and different groups of people uniquely vulnerable to heat
- Inclusion of health effects and health outcome data
- Incorporation of climate change in the framing of heat as a hazard, risk assessment, and mitigation planning
- Engagement with third parties, such as community members and nongovernmental organizations
- Detailed mitigation strategies specifically targeted to extreme heat

A higher score indicates more robust inclusion of heat as a hazard in a state's plan. The maximum score possible was 18, which no state received. The complete scoring framework and results for each state are provided in the Appendix.

Figure 1. State hazard mitigation plan scores



The factors to consider when scoring the treatment of extreme heat in SHMPs are relatively easy to delineate. However, the weighting or "value add" of each factor is significantly more challenging to assess. Many factors under consideration in scoring these plans are easy to include at a surface level, to "check a box." However, the degree to which these were (1) further developed, explored, and tied into the plan overall and (2) tailored to heat specifically as a hazard varied significantly. This was particularly prevalent in accounting for population vulnerability to heat and the influence of climate change on the future of heat as a hazard. Thus, equivalency in score is not necessarily representative of equivalency in the overall treatment of heat as a hazard in these plans. The scoring system could not wholly represent the overall cohesion of hazard identification, assessment, and mitigation strategies, though it serves as a useful starting point for an overall assessment of defining heat as a hazard in SHMPs.

Many points of discussion and recommendations here are discussed in the latest FEMA guidance for plan development, and some are explicit requirements already. This document is meant to serve as supplemental information, particularly as it relates to defining heat as a natural hazard.

KEY TAKEAWAYS

- **The importance of extreme heat is often understated in SHMPs because it is combined with other hazards.** Overall, only 25 states had a dedicated section in their SHMP for extreme heat, with 18 having heat combined with cold or drought. While the majority of states included heat separately or in a combined section, only 17 states assessed the geographic areas within their state that are most at risk. The starkest absence of extreme heat is seen in the lack of mitigation strategies included in SHMPs. Only 12 states had heat-specific mitigation strategies, with 8 of those states having targeted strategies that expanded beyond basic emergency preparedness. The heat-specific mitigation strategies of only 7 states targeted the populations most vulnerable to negative health outcomes.
- **FEMA guidance for SHMPs would be strengthened by further modernization of existing processes for risk identification.** Upcoming FEMA guidelines emphasize defining hazards based on discrete events; however, heat is often subtle and chronic, unlike singular severe weather events such as hurricanes. Additional requirements for hazard-specific mitigation efforts provide few incentives for states to include heat as a hazard when mitigation strategies are uncertain or funding sources are difficult to identify. Requiring mitigation strategies to address every hazard included in the plan creates a challenge for states because of a lack of information and understanding about appropriate heat mitigation and resilience strategies. This ultimately results in SHMPs that do not include heat as a hazard and creates a situation where heat is overlooked when establishing priorities for natural hazard planning. Additionally, requirements to specify agencies and individuals responsible for overseeing a given mitigation plan add an additional barrier. Although necessary, this presents additional challenges if heat-related mitigation strategies do not fit within the purview of a given agency. An increasing number of localities are formally designating chief heat officers to address this (Miami-Dade County 2023).

- **The risk assessment of heat relative to other hazards is less robust within current SHMPs because climate change is not adequately incorporated.** In the context of climate change, current impacts from extreme heat will be continually magnified. The detailing of a given hazard within a state's mitigation plan sets the foundation upon which future efforts to target these hazards are based. Half of the states discussed the impact of climate change on rising temperatures and the higher probability of extreme heat, but only 16 states considered this within the quantitative probability analysis for heat as a hazard. States in this assessment also only considered projected changes of one metric (e.g., maximum temperature). In many regions, increasingly persistent high overnight temperatures (minimum temperature) is a hallmark of climate change, and one with significant health implications. Failing to include these metrics makes it impossible to encompass the broad range and magnitude of impacts from climate change.

RECOMMENDATIONS

Recommendation 1: Establish a State-Specific, Standardized Definition of Extreme Heat

Use robust climate data to develop a state-specific definition of extreme heat that accounts for variations in temperature and heat-related illness rates across regions within the state.

In many parts of the country (e.g., the southeastern US), extreme heat is not defined by discrete heat events or heat waves. The current processes for risk identification emphasizes identifying (1) location, (2) previous occurrences, and (3) the range of observed intensities in defining each natural hazard. These details are clear, direct, and tangible, making a state's risk identification of most hazards feasible for agencies and individuals with limited time and resources. However, extreme heat is often (1) everywhere, (2) chronic, and (3) with observed intensity highly relative to location, climate, and population vulnerability. The recommendations for climate and health data that follow provide a starting point to better define what extreme heat means for individual states, and particularly how to define heat as a hazard with respect to occurrences and observed intensities.

Considerations and Metrics to Incorporate

Climate Data

Numerous types of climate data and sources for this data are readily available for inclusion in SHMPs. Many plans reviewed here use only one metric to define extreme heat, such as maximum daily temperature or days with temperatures 10°F above the normal maximum temperature. In addition to such measures, it is also useful to consider other metrics that have been directly linked with health outcomes, such as minimum overnight temperature, multiday averages, and heat stress indices.

- **Minimum nighttime temperature:** High overnight temperatures hinder an individual's ability to recover from heat exposure during the day, particularly for those most vulnerable to heat (e.g., those living in housing with poor insulation or those that can't afford to run air conditioning).

- **Multiday averages:** Because the cumulative impact of relatively high (but not extreme) heat over multiple days can cause negative health outcomes, consider averaging temperature or other metrics over one to three days for a more robust linkage with health outcomes.

- **Heat stress indices:** Heat stress indices are used to determine the degree to which conditions are dangerous because they more robustly account for the influence of air temperature (and other factors) on human body temperature.

    - **The heat index:** Commonly used in the United States, the heat index accounts for the influence of air temperature and humidity on the human perception of heat (a "feels like" temperature) (NWS n.d.a). Heat index values have been linked to varying levels of danger. These values vary somewhat based on region, as those living in colder climates experience negative health outcomes at cooler values of the heat index. A readily available source to see specific heat index thresholds for a specific area is the US National Weather Service (NWS). The US NWS uses the heat index as a key trigger for issuing heat advisories and warnings, but other factors may be considered depending on the local NWS weather forecast office.

    - **Wet bulb globe temperature (WBGT):** WBGT is even more robust than the heat index, accounting for the additional influence of solar radiation and wind speed on body temperature in combination with air temperature and humidity. Numerous states in the US now require the use of WBGT to determine if athletic practices can continue safely, which could be a possible heat mitigation strategy (see examples from North Carolina, Georgia, and the National Collegiate Athletic Association) (NCHSAA n.d., GHSA n.d., Chan 2019). OSHA recommends the use of WBGT in safeguarding health in occupational settings (OSHA 2022, OSHA 2017). The US NWS and National Oceanic and Atmospheric Administration's (NOAA's) Southeast Regional Climate Center produce forecasts of this variable (Convergence of Climate-Health Vulnerabilities 2023). However, using WBGT within SHMPs would likely require consultation and collaboration with experts.

Questions to Ask When Considering What Data and What Metrics to Use

- How much does the climate vary across the state (e.g., between urban and rural areas or between mountains and coastal regions)?

- Is coverage of weather stations consistent across the state to provide information on temperature variations from one region or county to another?

- Is the region more humid or dry? Is it generally windy? These questions frame which metric of heat would be most appropriate:

    - Air temperature: Dry climate

    - Heat index: Dry/humid, windy climate

    - WBGT: Humid climate

Data Sources (in Addition to Sources Directly Linked in FEMA Guidance)

- NWS can provide information on metrics they use to issue heat watches and warnings across your state (note, multiple NWS offices may cover your state, and their policies may differ). Additionally, historical archives of heat watches and warnings may be useful in better assessing the frequency of heat rather than simply trying to define individual, discrete heat waves (Iowa Environmental Mesonet [Iowa State University 2023b]).
- NOAA Regional Climate Centers are dedicated to providing climate services and assisting in data queries such as the ones needed to understand the frequency of heat levels in a state (NCEI 2023).
- State climate offices are located in each US state (AASC n.d.). They can be invaluable in better determining both the data to use and sources for that data. They are also great partners to engage with in the overall plan writing and editing process.
- Weather station data can be easily retrieved for all federally operated stations in a state (most commonly at airports) (i.e., the Automated Surface/Weather Observing Systems). Sources for downloading such data include Iowa Environmental Mesonet, NOAA Online Weather Data, Climate Data Online, and through Climate.gov (Iowa State University 2023a, NWS n.d.b, NCEI n.d., NOAA 2023). Some data sources may require more expertise and the ability to manually filter out errant data points. Many states also have weather station networks operated by universities or state climate offices (AASC n.d.).
- Other weather data that require more technical expertise but are robust in space and time include the ERA5 (hourly data, 1940–present) and PRISM (daily data, 1895–present) (ECMWF 2023, NACSE 2023).

Spatial Scales of Assessment

Ideally, climate and weather data should be assessed per county (not the state as a whole) given there may be wide variations caused by unexpected factors. While each county may not have a weather station, common techniques include assigning that county whichever weather station is closest or using data sets that provide continuous spatial coverage (see the previous note on "Other weather data").

Note: Consultation with climatologists (e.g., at universities, state climate offices, NOAA Regional Climate Centers) on the plan would best ensure all analyses framing the hazard of heat are robust.

Health Data

- **Linking health and climate data:** Defining the hazard of heat requires climate data; however, linking this climate data with health outcome data provides the most robust, well-rounded understanding of how heat affects health in each state. Incorporating this data enables understanding of the when, where, who, and at what temperatures of heat health impacts in the state. Framing the frequency of "heat" in the state by simply looking *x* days above *y* temperature does not account for the parallel issue of when people experience negative health outcomes.
- **Sources:** Some sources for such data include death certificates, which are publicly accessible; hospital data (emergency department visits and hospital admissions); reported

cases of heat injury to high school athletic associations; and OSHA incidences. State department of health and human services are likely able to highlight other sources, if available.
Note: For death certificates and hospital data, it is easy to filter out the deaths and injuries attributed to heat based on International Classification of Diseases codes (CDC 2022b). Hospital visit data is more challenging to obtain, but the state department of health and human services will be able to make this process easier.
Heat is often overlooked when diagnosing patients, particularly if the primary reason for the death or injury is an underlying condition (such as cardiovascular disease) where heat was the exacerbating factor.

- **Methodology:** A straightforward method for such work links the health outcome data for an individual with the relevant climate data by matching the date and location to understand the climactic conditions the individual may have been exposed to. The most robust way to link climate and health data would be to undertake a study that looks at "excess" deaths or emergency department visits/hospital admission. Instead of only looking at instances where heat was directly attributed, this provides important additional information on the instances where heat was a factor but was overlooked in diagnosis. Importantly, this also accounts for the instances where certain populations bypassed the systems capturing this health data due to barriers to care (e.g., affordability, cultural or language differences). Because of the time and expertise required to undertake such a study, this should be considered a long-term goal rather than an immediate recommendation.

Recommendation 2: Account for Variations in the Vulnerability of Different Groups Environmentally Exposed to Extreme Heat

Consider hazard-specific variations in vulnerability between groups of people, understanding that who is vulnerable and how they are vulnerable likely varies across different types of hazards.

Existing FEMA guidance emphasizes the importance of understanding and considering the variations in vulnerability across the population in each state. An additional challenge is considering hazard-specific variations in vulnerability (understanding that who is vulnerable and how they are vulnerable likely varies across different hazards).

Population groups uniquely vulnerable to heat include

- aging populations,
- children,
- student-athletes,
- pregnant people,
- laborers (outdoor, manufacturing/indoor),
- people with chronic illnesses/using prescription medications,
- and others dealing with economic factors such as energy poverty and housing insecurity.

Threshold Temperatures

Significant research has been conducted to understand how heat affects these vulnerable populations differently and, importantly, at what temperature environmental conditions become dangerous for them. Sources of data to provide a basis for understanding the who and where of heat vulnerability in each state can begin simply with considering the following census data:

- **Demographic:** Age, sex, race
- **Economic:** Income, occupation, health insurance coverage
- **Housing:** Type of housing, ownership versus renter rates, age of structure

An additional resource is the Climate and Economic Justice Screening Tool (CEQ 2022). Leveraging the health data discussed in Recommendation 1 further contextualizes information regarding other groups, such as laborers, those with chronic illnesses, and pregnant people.

Overlap of Vulnerability and Heat Metrics

Importantly, this information should then be linked and aligned with the geography of heat exposure. How do the areas experiencing higher levels of heat overlap with places that have more vulnerable populations?

Urban and Rural Areas

Significant emphasis is placed on the urban heat island effect, which is a valid concern. However, in many instances, this results in overlooking the very real vulnerabilities that exist simultaneously in rural areas. This is another instance where state-specific and region-specific insight is crucial. For example, in the South, manufacturing that often occurs in dangerously hot indoor conditions is concentrated in rural areas, compared to other parts of the country where it is concentrated in urban areas.

Overall, understanding where populations are located that are less likely or able to engage with the healthcare system, experience energy poverty, or have no choice but to continue working in dangerously hot conditions is far more critical than solely looking at vulnerability within a strict urban versus rural paradigm.

Recommendation 3: Adequately Incorporate Climate Change into Extreme Heat Assessments

Incorporate multiple metrics to capture changes in climate. For example, use maximum temperature along with other variables, such as minimum temperature and humidity, to understand the complexity of extreme heat in a changing climate. Combine these metrics with projected population changes (e.g., age distribution) to frame the future trajectory of heat hazards in each state.

The necessity of incorporating projected changes in climate in ranking the probability of natural hazards is thoroughly discussed in FEMA guidelines, and roughly half of current state plans already include such information. Strengthening the requirements for plans as it relates to the inclusion of climate change would encourage the development of long-term mitigation efforts. Hazard mitigation plans based on the most robust evidence currently available will minimize the need for substantive future changes.

Considerations

- Incorporate multiple metrics to capture changes in climate. For example, use maximum temperature along with other variables, such as minimum temperature and humidity, to understand the complexity of extreme heat in a changing climate. Do the changes in these metrics vary? Do these other metrics better correspond to health outcomes in one group or another?
- Combine these metrics with those about projected population changes (e.g., age distribution) to frame the future of heat as a hazard in the state and understand how these changes intersect with changes in climate.
- Compare predicted changes in heat across different emissions scenarios (Representative Concentration Pathway scenarios [EPA 2022]).

Ultimately, the goal is to use the climate and health data discussed in Recommendation 1 to accurately identify hazard-specific vulnerability (Recommendation 2), and robustly determine how climate change may alter current heat-health impacts. This will enable the development of mitigation strategies that are feasible, relevant, impactful, and long-lived.

The Fourth National Climate Assessments and Intergovernmental Panel on Climate Change Sixth Assessment Report provide regional projections for multiple temperature metrics that can be used to understand future scenarios of extreme heat (US Global Change Research Program 20218, IPCC 2021).

Recommendation 4: Develop Appropriate Mitigation and Resilience Strategies Based on Experience from Other States and Community Stakeholder Engagement

Involve experts and community stakeholders in the development process to ensure sustainable and realistic mitigation and resilience strategies for extreme heat. These include climatologists, public health experts, and community stakeholders such as planners, faith-based leaders, agricultural extension agents, athletic trainers, and others.

As noted in the NRDC scoring system, mitigation strategies that "go beyond just emergency preparedness and response" and explicitly target the most vulnerable populations are crucial.

Some example mitigation strategies and general considerations from high-scoring states are as follows:

Education and Awareness

- Year-round public information campaigns help communities build resilience against extreme heat by increasing awareness and supporting preparedness. Examples:
  - The Centers for Disease Control and Prevention (CDC) offers infographics that help the general public understand heat risk and prevention measures (CDC 2023).
  - The University of Sydney Heat and Health Research Incubator has developed Sustainable and Accessible Ways to Keep Cool to provide guidelines on individual cooling even in low-resource circumstances (Jay et al. 2022).

- Public warning systems (heat health warning systems) provide real-time warning and prevention recommendations during periods of extreme heat. Examples:
  - Linking climate and health data to define warning thresholds is critical (see Recommendation 1 and, for example, the Wisconsin Hazard Mitigation Plan [WEM 2021]). The current warning system operated by the US NWS provides a foundation for future systems and collaboration with the NWS would be advantageous. Communication of levels of dangers could be accomplished similarly to the Environmental Protection Agency's air quality warning system.
  - The University of Sydney Heat and Health Research Incubator is developing an application that communicates heat risk under the ultraviolet warning framework (Nine to Noon 2023).
- Training for athletic trainers/directors can help protect student-athletes from dangerous heat exposure. Student-athletes are particularly vulnerable to extreme heat because of frequent exposure and protective gear that makes it difficult to cool down. An increasing number of states are requiring the use of WBGT to determine if it is safe for outdoor athletic practice (Training & Conditioning 2021).
- Area Health Education Centers (AHECs) expand the capacity of the healthcare workforce and offer trainings to healthcare providers on a broad range of health topics, including extreme heat, particularly in rural and underserved areas (National AHEC Organization n.d.).
- Physician-patient interactions are important contact points with people who are most at risk for heat illness, injury, and death. This could be leveraged by educating health care providers and providing them with information (e.g., flyers, posters) that communicate heat risk and individual prevention practices.
- Suicide prevention hotlines can reduce suicide rates, which increase during periods of extreme heat.

Development and City Planning

- Consider where people are exposed in conjunction with future planning and development (e.g., at transit stops, bike pathways and greenways, and outdoor waiting areas for public facilities such as hospitals). Natural grass reduces heat stress by cooling the air through evapotranspiration, unlike other options such as artificial turf.
- Implement building codes that reduce heat burden such as using heat-abating building materials; insulation requirements that increase efficiency and retain cooling; heating, ventilating, and air conditioning efficiency; proper ventilation; and so on.
- Incentivize nature-based solutions and green infrastructure to ensure adequate green space (trees, vegetation), which lowers heat stress and can also improve mental health These mitigation strategies are also multihazard strategies (e.g., increased tree canopy can both mitigate flooding and reduce heat exposure).

- Identify existing infrastructure that can be adapted for heat mitigation. For example, faith-based organizations, schools, libraries, and community centers can be converted into cooling centers during times of extreme heat. Example:
    - New Orleans' Community Lighthouses [Together New Orleans 2022]).

State-Level Policies

- Adopt cooling standards for public housing and rental homes.
- Develop services through public agencies that help residents mitigate extreme heat.
    - Example: North Carolina Operation Fan and Heat Relief (NCDHHS 2023b).
- Expand cooling subsidies (see LIHEAP [NCDHHS 2023a]).
- Develop workplace requirements for monitoring heat stress (see OSHA's new guidance [2022]).
- Create syndromic surveillance systems to detect periods of unexpected increases in morbidity.
    - Examples: National Syndromic Surveillance Program (CDC 2023b) and the North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT 2023).

Note: Further details and additional examples can be found through the following resources: Adrienne Arsht-Rockefeller Foundation Resilience Center (n.d.), CDC/Building Resilience Against Climate Effects (BRACE) Program (Anderson et al. 2017), New York State Department of Environmental Conservation (2023), and CDC (2022a).

CONCLUSION

Traditionally, extreme heat has not consistently fit into the framework of hazard assessments; however, FEMA has recently declared extreme heat one of its priority topics. Heat is now incorporated into FEMA's Hazard Mitigation Assistance Program and is eligible for mitigation funding through opportunities such as BRIC grants and grants issued through HMGP. However, the competitive nature of these programs, along with the difficulty in completing grant applications, create a barrier to entry that is only exacerbated by confusion over whether heat is a qualifying hazard. Currently, there are no examples of successful applications to the BRIC program for heat mitigation projects. However, for the 2022 application cycle for BRIC and Flood Mitigation Assistance, FEMA has taken steps to address this by modifying the cost effectiveness thresholds for some mitigation efforts that could possibly include extreme heat (Bennett 2022). To successfully incorporate heat mitigation projects into its Hazard Mitigation Assistance Program, FEMA should resolve these barriers to entry and provide practical examples of successful heat mitigation projects in addition to recent generalized information regarding extreme temperatures (FEMA 2022a).

Recently, FEMA released the Hazard Mitigation Assistance Program and Policy Guide, which includes some examples of nature-based solutions for heat mitigation (FEMA 2023a). This, along with the recent declaration of heat as a priority, is a great step in overcoming the challenges around planning and preparedness for extreme heat. Next steps should include targeted guidance from FEMA regarding the funding eligibility of heat mitigation projects that expand beyond nature-based solutions.

Even without explicit guidance from FEMA, states can incorporate heat into their SHMPs, as demonstrated by several states, such as Oregon, Wisconsin, California. Those involved with the development of SHMPs should consider collaboration with experts to assist in defining extreme heat for their state, identifying vulnerable populations, and compiling mitigation strategies for organizations and individuals to reduce the impacts of extreme heat.

REFERENCES

AASC. n.d. *State Programs*. Asheville, NC: American Association of State Climatologists. https://stateclimate.org/state_programs/.

Anderson, H., C. Brown, L. L. Cameron, M. Christenson, K. C. Conlon, S. Dorevitch, et al. 2017. BRACE Midwest and Southeast Community of Practice. *Climate and Health Intervention Assessment: Evidence on Public Health Interventions to Prevent the Negative Health Effects of Climate Change*. Climate and Health Technical Report Series. Atlanta: Climate and Health Program, Centers for Disease Control and Prevention. https://www.cdc.gov/climateandhealth/docs/ClimateAndHealthInterventionAssessment_508.pdf.

Arsht-Rock. n.d. *Heat Action Platform.* Washington, DC: Adrienne Arsht-Rockefeller Foundation Resilience Center. https://onebillionresilient.org/heat-action-platform/.

Bennett, G. W. 2022. *Alternative Cost-Effectiveness Methodology for Fiscal Year 2022 BRIC and FMA Application Cycle*. Washington, DC: Federal Insurance and Mitigation Administration. https://www.fema.gov/sites/default/files/documents/fema_alternative-cost-effectiveness-methodology_102022.pdf.

CDC. 2022a. *Extreme Heat*. Atlanta: Centers for Disease Control and Prevention. https://www.cdc.gov/disasters/extremeheat/.

CDC. 2022b. *ICD-10-CM Browser Tool.* Atlanta: Centers for Disease Control and Prevention. https://www.cdc.gov/nchs/icd/icd10cm_browsertool.htm.

CDC. 2023a. "Heat," in *Infographics*. Atlanta: Centers for Disease Control and Prevention. https://www.cdc.gov/orr/infographics/#heat.

CDC. 2023b. *National Syndromic Surveillance Program (NSSP)*. Atlanta: Centers for Disease Control and Prevention. https://www.cdc.gov/nssp/index.html.

CEQ. 2022. *Climate and Economic Justice Screening Tool*. Washington, DC: Council on Environmental Quality. https://screeningtool.geoplatform.gov/en/#9.43/31.3291/-127.8154.

Chan, G. 2019. "Use of the Wet Bulb Globe Temperature in NCAA FBS Athletic Training Staffs" *All Graduate Plan B and Other Reports*. 1366. https://digitalcommons.usu.edu/gradreports/1366.

Constible, J. 2022. "Hazard Planners Aren't Planning for Heat Hazards." *NRDC*, December 7. https://www.nrdc.org/bio/juanita-constible/hazard-planners-arent-planning-heat-hazards.

Convergence of Climate-Health Vulnerabilities. 2023. Wet Bulb Globe Temperature (WBGT) Tool. Chapel Hill, NC: Carolinas Integrated Sciences & Assessment. https://convergence.unc.edu/tools/wbgt/.

ECMWF. 2023. *ECMWF Reanalysis v5 (ERA5)*. Reading, UK: European Centre for Medium-Range Weather Forecasts. https://www.ecmwf.int/en/forecasts/dataset/ecmwf-reanalysis-v5.

EPA. 2022. *Changes over Time*. Washington, DC: Environmental Protection Agency. https://www.epa.gov/enviroatlas/changes-over-time.

FEMA. 2022a. *FEMA Fact Sheet—Mitigating the Risk of Extreme Temperatures with Hazard Mitigation Assistance Funds*. Washington, DC: Federal Emergency Management Administration. https://www.fema.gov/sites/default/files/documents/fema_extreme-heat-fact-sheet_102022.pdf.

FEMA. 2022b. *State Mitigation Planning Policy Guide*. Washington, DC: Federal Emergency Management Administration. https://www.fema.gov/sites/default/files/documents/fema_state-mitigation-planning-policy-guide_042022.pdf.

FEMA. 2023a. *Hazard Mitigation Assistance Program and Policy Guide.* Washington, DC: Federal Emergency Management Adminstration. https://www.fema.gov/sites/default/files/documents/fema_hma-program-policy-guide_032023.pdf.

FEMA. 2023b. *Mitigation Planning Policy Updates*. Washington, DC: Federal Emergency Management Adminstration. https://www.fema.gov/emergency-managers/risk-management/hazard-mitigation-planning/updates.

GHSA. n.d. *BY-LAW 2.67 – "Practice Policy for Heat and Humidity."* Thomaston, GA: Georgia High School Association. https://www.ghsa.net/sites/default/files/documents/sports-medicine/Risk_Management_Policies.pdf.

Iowa Environmental Mesonet. 2023a. *ASOS-AWOS-METAR Data Download*. Ames, IA: Iowa State University. https://mesonet.agron.iastate.edu/request/download.phtml.

Iowa Environmental Mesonet. 2023b. *NWS Watches Warnings Advisories Download*. Ames, IA: Iowa State University. https://mesonet.agron.iastate.edu/request/gis/watchwarn.phtml.

IPCC. 2021. *Sixth Assessment Report*. Geneva: The Intergovernmental Panel on Climate Change. https://www.ipcc.ch/assessment-report/ar6/.

Jay, O., A. Capon, P. Berry, C. Broderick, R. de Dear, G Havenith, et al. 2021. "Reducing the Health Effects of Hot Weather and Heat Extremes: From Personal Cooling Strategies to Green Cities." *The Lancet*. doi:10.1016/S0140-6736(21)01209-5.

Miami-Dade County. 2023. *Chief Heat Officer*. Miami: Miami-Dade County. https://www.miamidade.gov/global/economy/environment/chief-heat-officer.page.

Munch, D. 2022. "2021 Disaster Estimatons Reveal at Least $12.5 Billion in Crop and Forage Losses." *fb.org*, March 10. https://www.fb.org/market-intel/2021-disaster-estimations-reveal-at-least-12.5-billion-in-crop-and-forage-l.

NACSE. 2023. *PRISM Climate Data*. Corvallis, OR: Oregon State University. https://prism.oregonstate.edu/.

National AHEC Organization. n.d. Alachua, FL: National AHEC Organization. https://www.nationalahec.org/.

NC DETECT. 2023. *North Carolina Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT)*. Chapel Hill, NC: University of North Carolina at Chapel Hill. https://ncdetect.org/.

NCDHHS. 2023a. *Low Income Energy Assistance (LIEAP)*. Raleigh: North Carolina Department of Health and Human Services. https://www.ncdhhs.gov/divisions/social-services/energy-assistance/low-income-energy-assistance-lieap.

NCDHHS. 2023b. *Operation Fan and Heat Relief*. Raleigh: North Carolina Department of Health and Human Services. https://www.ncdhhs.gov/divisions/aging-and-adult-services/operation-fan-and-heat-relief.

NCEI. 2023. *Regional Climate Centers*. Washington, DC: National Centers for Environmental Information. https://www.ncei.noaa.gov/regional/regional-climate-centers.

NCEI. n.d. *Climate Data Online*. Washington, DC: National Centers for Environmental Information. https://www.ncei.noaa.gov/cdo-web/.

NCHSAA. n.d. *Heat Guidelines for NCHSAA.* Chapel Hill, NC: North Carolina Student Athletic Association. https://www.nchsaa.org/sites/default/files/attachments/heat-guidelines.pdf.

New York State Department of Environmental Conservation. 2023. *Extreme Heat*. Albany, NY: New York State Office of Climate Change. https://www.dec.ny.gov/energy/125801.html.

Nine to Noon. 2023. “Heat Stress Scale Similar to a UV Index Could be Lifesaving.” *RNZ*, March 15. https://www.rnz.co.nz/national/programmes/ninetonoon/audio/2018881874/heat-stress-scale-similar-to-a-uv-index-could-be-lifesaving.

NOAA. 2023. *Daily Temperature and Precipitation Reports—Data Tables.* Washington, DC: National Oceanic and Atmospheric Administration. https://www.climate.gov/maps-data/dataset/daily-temperature-and-precipitation-reports-data-tables.

NWS. n.d.a *Heat Forecast Tools*. Washington, DC: National Weather Service. https://www.weather.gov/safety/heat-index.

NWS. n.d.b. *NOAA Online Weather Data (NOWData)*. Washington, DC: National Weather Service. https://www.weather.gov/climateservices/nowdatafaq.

NWS. 2021. *Weather Related Fatality and Injury Statistics*. Washington, DC: National Weather Service. https://www.weather.gov/hazstat/.

Office of Community Services. 2023. *Low Income Home Energy Assistance Program (LIHEAP)*. Washington, DC: US Department of Health & Human Services. https://www.acf.hhs.gov/ocs/low-income-home-energy-assistance-program-liheap.

OSHA. 2017. “Heat Stress,” in *OSHA Technical Manual (OTM)* Section III: Chapter 4. Washington, DC: Occupational Safety and Health Administration. https://www.osha.gov/otm/section-3-health-hazards/chapter-4.

OSHA. 2022. *OSHA Instruction: National Emphasis Program—Outdoor and Indoor Heat-Related Hazards.* Washington, DC: Occupational Safety and Health Administration. https://www.osha.gov/sites/default/files/enforcement/directives/CPL_03-00-024.pdf.

Parsons, L. A., Y. J. Masuda, T. Kroeger, D. Shindell, N. H. Wolff, and J. T. Spector. 2022. “Global Labor Loss Due to Humid Heat Exposure Underestimated for Outdoor Workers.” *Environmental Research Letters* 17: 014050. doi:10.1088/1748-9326/ac3dae.

Schmeltz, M. T., E. P. Petkova, and J. L. Gamble. 2016. “Economic Burden of Hospitalizations for Heat-Related Illnesses in the United States, 2001–2010.” *International Journal of Environmental Research and Public Health* 13(9): 894. doi:10.3390/ijerph13090894.

The White House. 2021. “Fact Sheet: Biden Administration Mobilizes to Protect Workers and Communities from Extreme Heat.” *The White House Briefing Room*, September 20. https://www.whitehouse.gov/briefing-room/statements-releases/2021/09/20/fact-sheet-biden-administration-mobilizes-to-protect-workers-and-communities-from-extreme-heat/.

Together New Orleans. 2022. *Community Lighthouse*. New Orleans: Together New Orleans. https://www.togethernola.org/.

Training & Conditioning. 2021. “Wet Bulb Globe Temperature Used by ‘Majority’ of NCAA ATCs.” *Training & Conditioning*, July 14. https://training-conditioning.com/news/wet-bulb-globe-temperature-used-ncaa-atcs/.

US Global Change Research Program. 2018. *Fourth National Climate Assessment*. Washington, DC: US Global Change Research Program. https://nca2018.globalchange.gov/.

WEM. 2021. *2021 State Hazard Mitigation Plan*. Madison, WI: Wisconsin Emergency Management. https://wem.wi.gov/state-planning/.

APPENDIX: STATE HAZARD MITIGATION PLAN SCORING FRAMEWORK AND RESULTS

Table 1. State hazard mitigation plan scoring framework

No.	Metric	Scoring
1	The plan includes a standalone risk assessment for heat hazards in the state.	1.0 = the risk assessment has a dedicated section for heat 0.5 = heat is combined with cold, drought, or wildfire 0.0 = no consideration of heat
2a	The risk assessment includes an analysis of the jurisdictions in the state most exposed to heat hazards.	1.0 = the heat risk assessment covers the entire state and is at the county scale or smaller 0.5 = only covers part of the state or uses a scale larger than the county level 0.0 = no analysis of the jurisdictions most exposed to heat
2b	The risk assessment considers the specific underserved or socially or medically vulnerable populations in the state that experience the greatest heat-related health harms.	1.0 = the risk assessment considers four or more categories of social or medical vulnerability 0.5 = considers one to three categories of vulnerability 0.0 = no analysis of underserved or vulnerable people
2c	The risk assessment considers how the jurisdictions in the state most exposed to heat overlap spatially and/or temporally with the underserved and social or medically vulnerable populations.	1.0 = yes 0.0 = no
3a	The risk assessment includes information about the historical, current, or expected heat-related health harms in the states.	1.0 = the risk assessment considers classic heat-related illnesses in addition to at least one other condition 0.5 = only considers classic related heat illnesses 0.0 = does not mention heat-related health harms
3b	The risk assessment includes heat-related illness, injury, or death data collected by the CDC, state agencies, and/or state health providers such as hospital systems.	1.0 = yes 0.0 = no
3c	The risk assessment attempts to quantify the historical, current, or expected health costs in dollars of heat-related health harms in the state.	1.0 = the risk assessment attempts to quantify health costs from illnesses, injuries, and deaths 0.5 = the health costs include deaths only 0.0 = no attempt to quantify health costs
3d	The risk assessment includes a discussion of how heat hazards could interrupt continuity of health-protective operations and services in the state.	1.0 = yes 0.0 = no

Table 1. State hazard mitigation plan scoring framework

No.	Metric	Scoring
4a	The risk assessment includes an analysis of how climate change will affect future heat hazards in the state.	1.0 = yes 0.0 = no
4b	The analysis of how heat hazards will change in the state includes both average temperatures and one or more clearly defined metrics of extreme heat.	1.0 = the analysis includes both average temperatures and one or more clearly defined metrics for heat extremes 0.5 = only includes heat extremes and/or fails to clearly define the main metric 0.0 = no analysis of averages or extremes
4c	The analysis of how heat hazards will change in the state is conducted at a sufficiently granular spatial scale.	1.0 = the analysis presents averages and extremes for the entire state at a substate scale 0.5 = only extremes are presented at a substate scale 0.0 = the spatial scale is at the state level or larger
4d	The probability of analysis of future heat extremes in the state considers climate projections or scenarios.	1.0 = yes 0.0 = no
5a	The mitigation strategy was informed by input from public health professionals.	1.0 = yes 0.0 = no
5b	Nongovernmental organizations or individuals representing the most vulnerable populations informed the mitigation strategy.	1.0 = yes 0.0 = no
6a	The mitigation strategy includes actions, activities, or projects explicitly intended to reduce heat risks.	1.0 = yes 0.0 = no
6b	The heat actions, activities, or projects in the mitigation strategy go beyond emergency preparedness and response.	1.0 = yes, including one or more strategies in the categories of land use planning, urban design, natural solutions, and/or heat-ready buildings 0.0 = no
7	The mitigation strategy prioritizes actions, activities, or projects to reduce heat risks to the most vulnerable populations.	1.0 = yes 0.0 = no
8	The mitigations strategy includes a timeline for implementation of heat actions, activities, or projects.	1.0 = yes 0.0 = no

Table 2. SHMP scores

State	Date of SHMP	Risk Assessment Category Score																		Total Score	Heat Officer? If Yes, State or City?
		1	2a	2b	2c	3a	3b	3c	3d	4a	4b	4c	4d	5a	5b	6a	6b	7	8		
Alabama	2018	0.5	1	0.5	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	6	No
Alaska	2018	0.5	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1.5	No
Arizona	2018	1	1	1	1	1	1	0	1	1	1	1	1	0	0	0	0	0	0	11	Yes (Phoenix)
Arkansas	2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No
California	2018	1	1	1	1	1	0.5	0	0	1	1	1	1	1	1	1	1	1	0	14.5	Yes (Los Angeles)
Colorado	2020	1	1	1	1	1	0	0	0	1	1	1	1	0	0	0	0	0	0	9	No
Connecticut	2019	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0.5	No
Delaware	2018	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	No
Florida	2018	1	1	1	1	0	1	0	0.5	0	0	0	0	0	0	0	0	0	0	5.5	Yes (Miami)
Georgia	2019	1	1	0	0	0.5	1	0	0	0	0	0	0	0	0	0	0	0	0	3.5	No
Hawaii	2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No
Idaho	2018	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	1	No
Illinois	2018	1	0.5	0.5	0	0.5	1	0	1	0.5	0	0	0	0	0	1	0	1	0	7	No
Indiana	2019	0.5	0	0	0	0.5	0	0	1	1	0	0	0	0	0	0	0	0	0	3	No
Iowa	2018	1	1	1	1	1	0	0	0	1	1	0	1	0	0	0	0	0	0	8	No
Kansas	2018	0.5	1	0.5	1	0.5	0	0	0	1	0.5	1	0	0	0	0	0	0	0	6	No
Kentucky	2018	0.5	0.5	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	No
Louisiana	2018	1	0.5	0.5	0	0	0	0	0	1	0.5	0	0	0	0	0	0	0	0	3.5	No
Maine	2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No
Maryland	2021	0.5	0.5	0	0	0	1	0	0	0	0	0	0	0	0	1	1	0	0	4	No
Massachusetts	2018	1	1	1	1	0.5	1	0	0	1	1	1	0	1	0	1	1	0	1	12.5	No
Michigan	2019	1	1	0.5	1	1	1	0	0	0	0	0	0	1	0	0	0	0	0	6.5	No
Minnesota	2019	1	1	1	0	0.5	0	0	0	1	0.5	0.5	1	1	0	1	0	0	1	9.5	No
Mississippi	2018	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	No
Missouri	2018	0.5	1	1	1	0.5	1	0	0	0	0	0	0	0	0	0	0	0	0	5	No
Montana	2018	0.5	1	0	0	0	0	0	0	1	0.5	1	0	0	0	0	0	0	0	4	No

Table 2. SHMP scores

State	Date of SHMP	Risk Assessment Category Score																		Total Score	Heat Officer? If Yes, State or City?
		1	2a	2b	2c	3a	3b	3c	3d	4a	4b	4c	4d	5a	5b	6a	6b	7	8		
Nebraska	2021	0.5	0.5	0	0	0	0	0	0	0	0.5	0.5	0	0	0	0	0	0	0	2	No
Nevada	2018	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	No
New Hampshire	2018	0.5	0	0.5	0	0	0	0	1	1	0.5	0	0	1	0	1	0	0	0	5.5	No
New Jersey	2018	0.5	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0.5	0	0	1	3	No
New Mexico	2018	1	0.5	0.5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	No
New York	2019	1	1	1	0	0.5	1	0	0	0	0	0	0	1	0	1	1	1	0	8.5	No
North Carolina	2018	1	1	0.5	0	0.5	1	0	1	0	0.5	0	0	0	0	0	0	0	0	5.5	No
North Dakota	2018	0.5	0	0	0	0	1	0	0	1	0.5	0	1	0	0	0	0	0	0	4	No
Ohio	2019	0	0	0	0	0	0.5	0	1	1	0.5	0	1	0	0	1	1	0	0	6	No
Oklahoma	2019	1	0.5	0.5	0	0.5	1	0	1	1	0.5	0.5	1	0	0	0	0	0	0	7.5	No
Oregon	2020	1	1	1	1	1	1	0	1	1	1	1	1	1	1	1	1	1	1	17	No
Pennsylvania	2018	0.5	1	0	0	1	1	0	1	1	0.5	0	1	0	0	0	0	0	0	7	No
Rhode Island	2018	1	1	1	0	0.5	1	0	1	0	0.5	0	1	0	0	1	1	0	1	10	No
South Carolina	2018	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	No
South Dakota	2019	0.5	0	0	0	0	1	0	0	1	0.5	0	0	0	0	0	0	0	0	3	No
Tennessee	2018	0.5	1	0	0	0	1	0	0	1	0.5	0.5	0	0	0	0	0	0	0	4.5	No
Texas	2018	1	0.5	0	0	0.5	1	0	0	1	1	1	0	0	0	0	0	0	0	6	No
Utah	2019	0.5	1	1	0	0.5	1	0	1	1	0.5	0	1	0	0	1	1	1	1	11.5	No
Vermont	2018	1	1	1	1	1	1	1	1	1	1	1	1	0	1	0	0	1	0	14	No
Virginia	2018	0.5	0.5	0	0	0	0	0	0	0.5	0	0	0	0	0	0	0	0	0	1.5	No
Washington	2018	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	2	No
West Virginia	2018	1	0.5	0.5	0	0.5	0	0	0	1	0	0	1	0	0	0	0	0	0	4.5	No
Wisconsin	2021	1	0	1	0	1	1	1	1	1	1	0.5	1	0	0	1	0	1	0	11.5	No
Wyoming	2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	No

Author Affiliations

Jordan Clark, Nicholas Institute for Energy, Environment & Sustainability, Duke University
Ashley Ward, Nicholas Institute for Energy, Environment & Sustainability, Duke University

Citation

Clark, J., and A. Ward. 2023. *Defining Extreme Heat as a Hazard: A Review of Current State Hazard Mitigation Plans*. NI R 23-03. Durham, NC: Duke University. https://nicholasinstitute.duke.edu/publications/defining-extreme-heat-hazard-review-current-state-hazard-mitigation-plans.

Acknowledgments

Thanks go to Langston Alexander and Jessica Sheldon.

Review

This report was reviewed by experts in the field of emergency management, planning, and preparedness.

Cover image by Michael Walker via iStock

Publication Number: NI R 23-03

Nicholas Institute for Energy, Environment & Sustainability

The Nicholas Institute for Energy, Environment & Sustainability advances Duke University's efforts to build a more sustainable world, working closely with Duke schools and other units. The Nicholas Institute develops transformative educational experiences; galvanizes and conducts impactful research; and engages with key decision-makers at the global, national, state, and local levels. The Nicholas Institute's team of economists, scientists, lawyers, and policy experts has developed a strong reputation for delivering timely, credible analysis and for convening decision-makers to advance actionable solutions to pressing energy and environmental challenges.

Contact

Nicholas Institute
Duke University
P.O. Box 90467
Durham, NC 27708

1201 Pennsylvania
Avenue NW
Suite 500
Washington, DC 20004

919.613.1305
nicholasinstitute@duke.edu