

A Maturity Model for Heat Governance

Initial Version, released June 2024



Table of Contents

Preface..... 1

 Introduction and Motivation..... 1

 Lessons Learned About Heat Governance 2

A Heat Governance Maturity Model 5

 Figure 1 Dimension Grouping for Heat Governance Maturity Model..... 6

 Figure 2 Institutional Dimensions7

 Figure 3 Partnership and Network Dimensions 9

 Figure 4 Asset Dimensions..... 11

References..... 13

Appendix..... 14

Acknowledgments 17

Preface

Communities across the U.S. and around the world are striving to prepare for the impacts of extreme heat on people, businesses, and industries. In response to record-breaking heat events that can claim hundreds of lives as well as chronic heat that can strain worker health and productivity as well as the economy, governments are in search of the most effective solutions to reduce heat risk. But the nature of heat risk is highly context-dependent. It can result from punctuated humid heat waves or chronic arid heat; it can be exacerbated by the urban heat island effect or by a local agricultural economy dependent upon outdoor work. It can be due to characteristics that may make a population at higher risk from heat, such as being an older adult, having a pre-existing health condition, having a low income, or being unhoused or poorly housed—and it can be all of the above at once.

While there is no one-size-fits-all solution, a general framework for understanding how government institutions can work together to address a complex risk structure is needed to address heat risk. In this guide, we present a novel **Maturity Model for Heat Governance** that allows leaders and decision-makers to examine their institutional posture to successfully manage heat risk. This model is a living document that will continue to evolve as it is applied in more contexts, and it was developed to be applicable to a diverse range of communities and governments from the start. Communities are invited to apply this model to understand gaps and challenges that should be addressed, and suggestions are welcome to improve this guide and the maturity model it describes.

Introduction and Motivation

The National Oceanic and Atmospheric Administration (NOAA), in collaboration with state and local partners across the nation, hosted a series of [Climate and Equity Roundtable events](#) in the Fall of 2021. The roundtables began conversations with local organizations working to build equitable resilience to hazards such as flooding, heat, and drought (see the [NOAA Strategic Plan for FY 2022-26](#) for more details). They sought to understand the shared and unique challenges of each place as well as to identify opportunities to improve NOAA's science, services, and stewardship to better support communities. Heat, health and equity issues were the primary focus of four communities: Las Vegas, NV; Phoenix, AZ; Charleston, SC; and Miami, FL. During these conversations, the participants, which included city or county officials, academic researchers, and representatives of community-based organizations, outlined the ways in which heat impacts their communities, with an emphasis on impacts to the elderly, racial/ethnic minorities, and those experiencing homelessness or energy insecurity. The participants also described their efforts and challenges in building resilience to heat impacts within their communities.

Heat and Health Equity Pilots

Following the roundtables, NOAA took action on its conversations with communities by developing [Heat and Health Equity Pilots](#) in the Spring of 2022 (hereafter, referred to collectively as “the Pilots”). These pilots consisted of four phases intended to understand the local context of heat and to build equitable resiliency.

OBSERVE AND UNDERSTAND

The Pilots built on the participatory science heat mapping activities of the [National Integrated Heat Health Information System \(NIHHIS\)](#) to bring community members and leaders together to collect hyperlocal information about heat exposure and to promote shared understanding of the high-risk areas and opportunities to address them.

ASSESS CURRENT PLANS

Tabletop exercises (see Heat Tabletop Exercise Guide) were developed with a diverse set of participants (similar to the Roundtables) and focused not only on heat preparedness and response, but also on building equitable long-term resiliency to heat. The tabletops exercised existing heat plans and governance, and helped participants learn about good practices as well as areas for improvement.

Throughout these four steps, ongoing engagement was fostered through a series of regular virtual and in-person meetings, both community-specific and cohort-based, so that communities could learn from each other.

IDENTIFY GAPS AND MAKE A PLAN

After the tabletops, an After Action Report (AAR) was developed to capture the lessons learned and to support planning for future action. While the AAR was a deliverable of the tabletops, it was also part of a larger ongoing conversation with the communities about opportunities to improve heat resilience.

TAKE ACTION

The culmination of the pilot approach was to take incisive action to address one or more of the gaps identified in the prior steps, experimenting with a new approach to protecting people from heat impacts. These actions are context-based and focused on specific and measurable outcomes.

Lessons Learned About Heat Governance

During these engagement activities, the planners were struck by the diversity among the Pilots in their respective heat challenges, as well as governance systems (see text box on page 3) for managing heat risks. In Phoenix, an [office within the city government](#) was created to lead efforts on heat response and heat mitigation. In Miami, there is a [Chief Heat Officer](#) working across existing city departments and external partners with the same goal. In Charleston, a [Chief Resilience Officer](#) has the responsibility to simultaneously address a wide range of hazards, with extreme heat only recently emerging as a priority

in a portfolio historically focused on coastal hazards, such as sea level rise and inundation. In Las Vegas and Clark County, a number of city and regional organizations (e.g., [City of Las Vegas Office of Sustainability](#), [Clark County Office of Sustainability](#), [Regional Transportation Commission of Southern Nevada](#)) are involved in efforts to manage heat risks, but no coordinating body or centralized authority for heat governance currently exists. Other differences among the Pilots can be found in the partnerships they maintain, as well as the human, financial, and technical resources and capacity directed toward heat-related programs.

Within the small Pilot cohort, the diversity of organizations, as well as the limits to their authorities and capacities, illustrated several key challenges discussed in the literature around heat governance.

- A clear “problem owner” (Klok and Kluck 2018) for addressing and managing heat risks is not always identified, authorized, or funded to pursue solutions.
- “Siloed and fragmented decision-making inhibit effective extreme heat planning and that more collaboration, or knowledge integration, is needed across city departments, levels of government, academic disciplines, and stakeholder groups” (Keith et al., 2019).
- Heat issues are often competing with other planning and sustainability issues for attention and resources (Keith et al., 2019).
- The literature that focuses on heat governance is relatively thin compared to the literature that models heat and heat exposure (Keith et al., 2019), implying that any “best practices” for heat governance are in early stages of development.

Through collaboration with the Pilots, and guided by relevant literature, NOAA sketched out a maturity model for heat governance. This maturity model may provide a pathway to effective governance

What is “heat governance?”

NOAA refers to “heat governance” as “the actors, strategies, processes, and institutions that can mitigate and manage” heat risks, following Keith et al (2021). From these experiences, “the actors” or “institutions” can include a wide range of public (e.g., state or county public health agencies, municipal planning organizations), private (e.g., utilities), academic, religious, and non-profit organizations. These organizations have a wide range of roles and responsibilities in managing and responding to extreme heat.

In some cases, the roles and responsibilities of an organization are codified explicitly, such as in a piece of legislation that creates the organization, or implicitly through planning or budget documents. However, in other instances, an organization’s role may be more informal, and does not correspond with a specific legal or budgetary obligation or responsibility. For example, many faith-based organizations are critical providers of cooling space and water, and will connect individuals to other important social services. Similarly, academic researchers often inform heat planning activities, or act as a convener among relevant groups, even without a formal obligation or responsibility to do so.

over the challenges of managing heat risks. It is the hope that the model can help the Pilots and other localities assess the current state of their heat governance, and highlight opportunities for developing or strengthening processes and institutions that can address heat risks. If used over time, the model could also be used to track progress toward building heat resilience.

The sections below introduce the ten dimensions of the model, and describe how the Pilots have begun to apply the model to their respective heat planning efforts.

What is meant by “local?”

The organizations involved in heat mitigation and response operate over a wide range of jurisdictional scales. Community-based non-profit organizations typically focus on issues at the neighborhood scale, while organizations embedded within city or county government operate over a broader geographic footprint. State and federal entities typically focus on broader scales and invoke different authorities. Within the context of this paper, and the Heat Health and Equity Pilot work more generally, the term “local” is used to refer collectively

to activities occurring on scales smaller than state or federal. The demarcation of “local” is somewhat arbitrary; most organizations maintain interests and networks that expand their reach across jurisdictional boundaries. However, most planning and resource-allocation decisions associated with heat mitigation and response currently occur at the county, city, and neighborhood levels. There are fewer examples of consistent roles for state and federal entities, hence the emphasis on “local” organizations.

A Heat Governance Maturity Model

Maturity models have been used frequently in organizational management or product development (Wendler et al., 2012). These models can be used to assess performance, create goals for organizational or product improvement, and/or measure progress over time. In the environmental field, maturity models have also been applied to [corporate sustainability planning](#), [urban resilience](#), and climate adaptation in the transportation sector (Kwiatkowski and Chinowsky 2017).

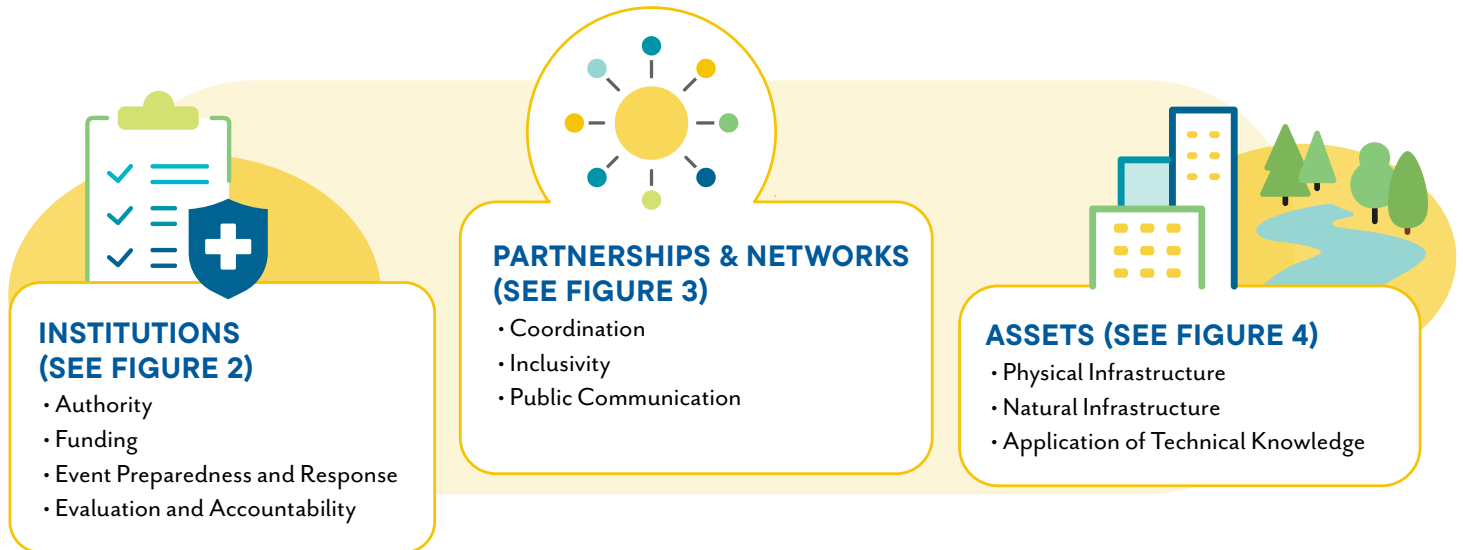
In general, a maturity model identifies a number of attributes (hereafter “dimensions”) that are related to organizational capability and performance. Within each dimension, a number of levels of increasing complexity or sophistication are prescribed. An organization can use qualitative or quantitative metrics to classify itself into a specific level for each dimension. Over time, progress is measured by assessing the extent to which the organization “levels up” within each dimension.

For the heat governance maturity model, ten dimensions have been identified:

- Authority
- Coordination
- Evaluation and Accountability
- Event Preparedness and Response
- Inclusivity
- Funding
- Natural Infrastructure
- Physical Infrastructure
- Public Communication
- Application of Technical Knowledge.

For ease of visualization, the ten dimensions have been organized into three groups: Institutions, Partnerships and Networks, and Assets (Figure 1).

Figure 1 Dimension Grouping for Heat Governance Maturity Model



For each dimension, there are five levels of maturity, each of which is described briefly in Figures 2–4 and in more detail in the Appendix. Level 1 represents the most basic level and level 5 corresponds to the most mature or most sophisticated. It is assumed that lower levels are prerequisites or precursors for higher levels.

In the remainder of this section, we provide illustrative scores from a hypothetical municipality using radar diagram displays. For each dimension, we describe the maturity levels and include a set of questions to help a practitioner assign scores to their locality.

Figure 2 Institutional Dimensions: Authority, Funding, Event Preparedness and Response, and Evaluation and Accountability

AUTHORITY

Level 1: Ad hoc management

Level 2: Implicit authority

Level 3: Explicit authority

Level 4: Explicit authority documented in heat plan

Level 5: Explicit authority with policy-making role

FUNDING

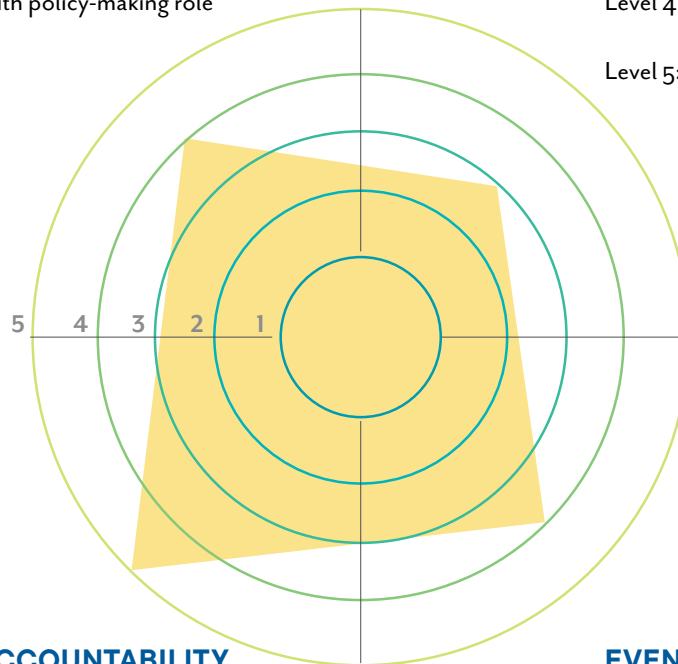
Level 1: No clear funding mechanism

Level 2: Time-limited support for projects

Level 3: Funding exists for staff programs but not tied to heat

Level 4: Time limited support for heat specific staff/programs

Level 5: Permanent funding for staff/programs



EVALUATION AND ACCOUNTABILITY

Level 1: Limited or no E&A

Level 2: One-off E&A examples

Level 3: E&A occurring annually

Level 4: E&A occurs during heat season, public involved

Level 5: E&A informs policy/protocol changes, integrated with community engagement

EVENT PREPAREDNESS AND RESPONSE

Level 1: Limited EM awareness of heat risks

Level 2: EM engagement with heat planners

Level 3: Limited experience with heat but appears in hazard plans

Level 4: Regular heat/EM coordination emerging

Level 5: Hazard planning well integrated with heat planning

“EM” refers to “emergency management” and “E&A” refers to “evaluation and assessment.” More detail about each level of maturity are provided in the Appendix.

The levels of maturity for each institutional dimension (Authority, Funding, Evaluation and Accountability, and Event Preparedness and Response) are listed above. Each dimension may be at a different level of maturity. The radar plot provides an example of an overview of the maturity of all four institutional dimensions at once. In this example, the bolded maturity levels for each dimension correspond to the level portrayed in the radar plot. For example, Evaluation and Accountability are portrayed as the highest maturity in this example (level 5), while Funding is lower (level 3).

Each of the Institutional dimensions is described below with a set of questions. A heat planner would think through these questions in order to determine the level that best describes their locality's current state of maturity.

Authority

Is there an organization or a set of organizations that is responsible for managing heat risks?

Is heat the organization's sole responsibility, or is heat one of many responsibilities that the organization has (i.e., an agency focused on sustainability, resilience, or public health)?

Does this organizational lead have power to make policies (e.g., establish programs, set or recommend regulations)? How is this program connected to and viewed by existing authorities (e.g., Mayor's Office; City Council; State Legislature; existing city, county, or state agencies)?

Funding

Is there financial support for the organizations that are leading the efforts to reduce heat risks?

Is this support time-limited in any way? Can the organization(s) direct funding to programs or other partners?

Event Preparedness and Response

Are there emergency management plans for heat events? If so, are emergency management staff aware and trained for responding to heat events? Is emergency management planning coordinated with heat planning?

Evaluation and Accountability

Are there processes for evaluating and assessing the response to and planning for heat events?

Are these evaluations and assessments conducted regularly, and do they feed back into alterations of procedures, programs, and policies? How are these evaluations and assessments shared?

Figure 3 Partnership and Network Dimensions:
Coordination, Inclusivity, and Public Communications

COORDINATION

Level 1: Limited coordination

Level 2: Informal, local coordination

Level 3: Formal coordination. May extend across scales

Level 4: Cross-scale coordination. Private and community
orgs involved

Level 5: Mature relationships across scales and among
diverse orgs

INCLUSIVITY

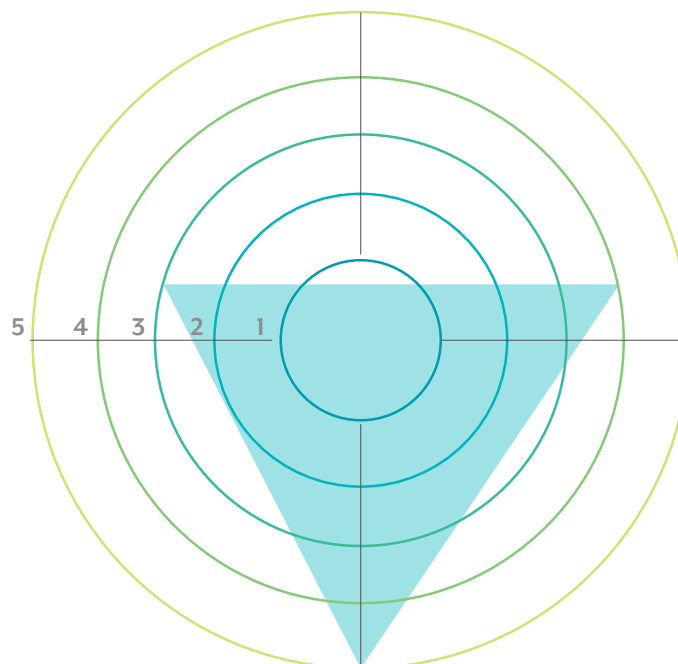
Level 1: Only public-sector agencies involved

Level 2: Public sector agencies consult subject matter experts

Level 3: Informal consultation occurs

Level 4: Formal advisory or accountability processes exist

Level 5: Frontline community interests drive policy decisions



PUBLIC COMMUNICATION

Level 1: Limited, uncoordinated public messaging

Level 2: Periodic messaging tied to heat season milestones

Level 3: Campaigns and branding help unify messaging

Level 4: Multi-language, multi-venue messaging

**Level 5: Targeted, two-way communication with most
impacted neighborhoods**

The levels of maturity for each partnership and network dimension (coordination, inclusivity, and public communication) are listed above. Each dimension may be at a different level of maturity. The radar plot provides an overall view of the maturity of all three partnership and network dimensions at once. In this example, the bolded maturity levels for each dimension correspond to the level portrayed in the radar plot.

As above, the Partnership and Network dimensions correspond with the following questions.

Coordination

In what ways and across what scales do the organizations involved in managing heat risks work together?

Inclusivity

How diverse are the organizations that manage heat risks? Do they represent a combination of public, private, and academic organizations? Are the organizations that work with frontline communities at the table, and to what extent can these groups influence decisions?

Public Communication

How and at what frequency do the organizations involved in managing heat risks communicate with the broader public, especially those considered highly exposed to or at risk of heat impacts?

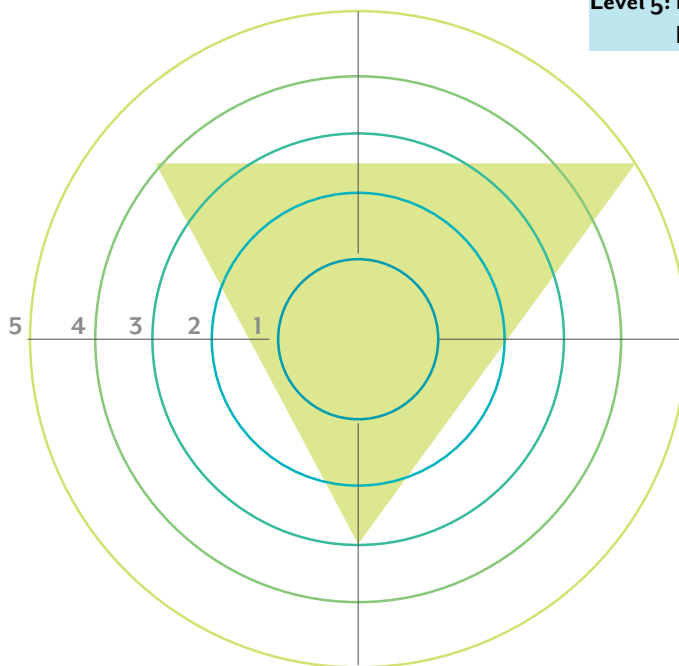
Figure 4 Asset Dimensions: Physical Infrastructure, Natural Infrastructure, and Applications of Technical Knowledge

PHYSICAL INFRASTRUCTURE

- Level 1: Cooling centers, electric grid, and housing stock are inadequate
- Level 2: Small scale projects. Improve infrastructure resilience
- Level 3: Guidance or regulations aim to improve new infrastructure
- Level 4: System-wide infrastructure upgrades underway**
- Level 5: Infrastructure is "heat ready"

NATURAL INFRASTRUCTURE

- Level 1: Access to natural cooling is insufficient and inequitably distributed
- Level 2: Projects to expand natural cooling exist but are uncoordinated
- Level 3: Plans or regulations exist to expand natural systems that provide cooling
- Level 4: Plans, programs, or regulations successfully expand access to natural spaces for heat relief
- Level 5: Natural systems are clearly and equitably integrated into heat planning efforts**



APPLICATIONS OF TECHNICAL KNOWLEDGE

- Level 1: Local heat hazard data are not available or rarely used in decision-making
- Level 2: Local heat climatology and heat island influence are known
- Level 3: Heat impact data are regularly collected and assessed**
- Level 4: Relationships among heat drivers, impacts, and outcomes are modeled, assessed, and predicted
- Level 5: Real-time operational capabilities exist, and actionable information is delivered to relevant users

The levels of maturity for each asset dimension (physical infrastructure, natural infrastructure, and applications of technical knowledge) are listed above. Each dimension may be at a different level of maturity. The radar plot provides an overall view of the maturity of all three asset dimensions at once. In this example, the bolded maturity levels for each dimension correspond to the level portrayed in the radar plot.

Finally, the Asset dimensions contain the following questions.

Physical Infrastructure

How resilient are the region's housing stock and utilities to heat stress? What is the capacity of cooling centers, relative to the number of people who may need to access them?

Natural Infrastructure

To what extent is natural shading or other nature-based solutions (e.g., access to lakes or rivers) being protected or expanded (e.g., through urban canopy or park programs)? Are canopy, shading, and park access equitably distributed throughout a city or region? Will natural infrastructure be sustainable, given anticipated future water demands and land development?

Applications of Technical Knowledge

What information is available about the frequency, intensity, and duration of heat events in the past, present, and future? What information is available about exposed and at-risk individuals and neighborhoods? How are these types of information used to inform decisions?

The vision is that a practitioner could categorize or score the current state of heat management and planning in their respective locality for each dimension. Alternatively, the practitioner could develop an engagement activity around the categorization process, bringing in an audience of partners to perform the categorization/scoring. The practitioner could use the results of the categorization/scoring to inform future prioritization and investments, applicable to their own organization or to the locality more broadly.

This Heat Maturity Model was developed in collaboration with four communities throughout the U.S and is being released as an initial version 1.0. We welcome communities to apply this model and share feedback on this document. We intend to continue to develop this approach to evaluating heat governance over time. Please reach out to nihhis@noaa.gov with any questions or comments you may have.

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Appendix Institutional Dimensions for the Heat Governance Maturity Model (see Figure 2)

LEVEL ONE	LEVEL TWO	LEVEL THREE	LEVEL FOUR	LEVEL FIVE
AUTHORITY				
Organizations address heat on an ad hoc basis as part of normal ops (“when it comes across your desk”)	One or more organizations have an implicit or informal role in leading local efforts (“as a resilience/ sustainability/ emergency management professional, it’s in my portfolio”)	One or more organizations have staff that are explicitly dedicated to building heat resilience (“it’s in my job title and/or job description”)	One or more organizations have formal responsibilities to manage heat (there’s a heat office or heat officer), and these responsibilities are documented (e.g., in a heat action plan)	Recognized organizational lead has policy-making authority that is viewed as legitimate, or has been explicitly granted, by established authorities (e.g., Mayor, City Council, State Legislature)
FUNDING				
Lack of identifiable funding to support heat work in the region	Support for individual projects exists, but is time limited (e.g., a grant, a part-time fellowship)	Support for staff and programs exist, but are not explicitly tied to heat preparedness and management (e.g., a resilience officer exists)	Support for heat-specific staff and programs exists, but is time limited (e.g., less than 5 years in duration)	Organizational lead has established, multi-year funding (>5 years) and the budgetary authority to direct funding to other entities
EVENT PREPAREDNESS AND RESPONSE				
Emergency managers lack specific plans for heat; the emergency management community rarely trains for heat events, rarely engages in heat discussions, and may consider heat risks a relatively low priority	Emergency managers are engaged in discussions with local or regional organizations managing heat risks, but their role remains poorly defined	Heat risks are mentioned in local, county, or state hazard plans. However, there is still minimal experience in responding to a heat event when compared to other weather hazards (e.g., flood, hurricane, wildfire, tornado)	Regular interaction exists between the emergency management community and heat management organizations. Examples exist of coordination between emergency management plans and longer-term heat initiatives, although this coordination is nascent/new	Hazard plans are well integrated with heat management efforts, with regular coordination and collaboration among responsible organizations. Responders practice heat responses in ways that are comparable to traditional weather-related hazards
EVALUATION AND ACCOUNTABILITY				
Limited or no evaluation of the impacts of specific heat events. No clear process for organizations to hold agencies/ leadership accountability on efforts related to heat resilience	Assessments of the impacts of heat events are conducted occasionally. “One-off” efforts to identify gaps in heat governance have occurred	Assessments of heat impacts are conducted on a regular, annual basis. Discussions about improving the management of heat risks at the local, regional, or state levels occur frequently in informal settings (e.g., conferences/workshops, academic research activities)	Assessments of heat impacts are conducted regularly, and can be generated within the heat season (e.g., weekly or monthly). Formal accountability processes exist that draw on public input (e.g., town halls, advisory groups) to guide future improvements in heat planning	Level 4 + evaluation and adjustments to policies are conducted in real time and responsive to all input. Evaluation and accountability measures, data, and reports are fully open and public, and shared widely. Lessons learned from other community evaluations are also infused into practice in this community

Partnership and Network Dimensions for the Heat Governance Maturity Model (see Figure 3)

LEVEL ONE	LEVEL TWO	LEVEL THREE	LEVEL FOUR	LEVEL FIVE
COORDINATION				
Limited coordination among organizations; most efforts are conceived/executed by a single agency	Informal coordination among a group of local organizations exists (e.g., shared event sponsorship, grant application collaboration, combined engagement with organizations from other locations or levels of governance)	Formal coordination exists (e.g., through shared funding or shared programs that are not one-offs or time limited, through MOUs or other documents). Coordination may extend across levels of governance (city - county - state - federal)	Coordination extends across levels of governance (city, county, state, federal), and extends to non-public sector partners (community-based organizations, utility providers, media)	Coordination mechanisms across levels of governance and non-governmental partners are mature, well-documented, and agreed upon by all parties. They are regularly reviewed and adjusted as needed
INCLUSIVITY				
Only public sector organizations are involved in deliberative processes/decision making; decisions are often made internally without much consultation of private, academic, or nonprofit groups	Informal partnerships exist between public sector organizations and subject matter experts (typically academic) that inform decision-making processes	Informal consultation processes exist, and involve a diverse set of organizations involved in managing heat risks (e.g., public, private, academic, non-profit, community-based)	Formal processes (e.g., oversight boards, advisory committees) exist that enable diverse organizations to influence decision-making and/or accountability	Level 3 + public sector organizations' missions and decision-making processes focused on extreme heat prioritize the voices and perspectives of frontline communities. Decision-making regularly draws upon community engagement mechanisms. Individuals from heavily impacted neighborhoods and representatives of community-based organizations are formally recognized as critical participants in setting priorities and executing programs
PUBLIC COMMUNICATION				
Limited, uncoordinated (with other partners) external communication to the general public is conducted (e.g., social media)	Organizations coordinate messaging and activities periodically, often tied to heat season milestones or issuance of heat warnings	Regular coordination across agencies on established public messaging campaigns (e.g., standing meetings among communications staff from multiple organizations, branding and iconography utilized)	Multi-language, multi-venue communications (TV, radio, billboard, social media, digital alerts (phone). Limited or ad hoc involvement of neighborhood-level organizations as developers of the messaging	Targeted two-way communication with neighborhoods or populations of high exposure and/or high vulnerability. Routine evaluation of communication effectiveness (e.g., surveys, analytics)

Asset Dimensions of the Heat Governance Maturity Model (see Figure 4)

LEVEL ONE	LEVEL TWO	LEVEL THREE	LEVEL FOUR	LEVEL FIVE
PHYSICAL INFRASTRUCTURE				
Cooling center capacity is well below demand. Electrical grid reliability is frequently challenged during past heat events. Housing stock and commercial buildings are relatively energy inefficient when compared to current building requirements	While existing health, power, and housing/commercial infrastructure is not adequate for addressing heat events, small-scale or pilot projects exist to bolster heat resilience	Level 2 + guidance or regulations exist to ensure that new infrastructure investments in health facilities, the electrical grid, and residential/commercial buildings will adhere to standards that take into account the frequency and intensity of future heat events	Level 3 + system-wide or large-scale upgrades of health facilities, the power grid, and building stock are underway	Cooling centers have transitioned to resilience hubs and are primarily used only for emergencies. All homes are able to maintain safe temperatures through energy efficient means. All people experiencing homelessness have heat safe accommodations. All utilities (e.g. energy, transportation, water) are heat ready and fully functioning in support of heat resilience
NATURAL INFRASTRUCTURE				
Access to natural cooling is insufficient and inequitably distributed - this could be measured by canopy differences, park access, or other locally appropriate metrics	Projects to expand natural cooling exist, but are uncoordinated across the locality/region. The projects may not take heat benefits into account	Plans or regulations exist to expand natural systems that provide cooling. (e.g., goals to expand urban forestry, efforts to expand park access and facilities to combat heat impacts)	Plans, programs, or regulations can demonstrate results in expanding access to natural spaces that provide heat relief	Natural systems are clearly integrated into heat planning efforts. Access to natural spaces that provide heat relief is equitable across the locality/region
APPLICATIONS OF TECHNICAL KNOWLEDGE				
Local heat hazard data may be available, but is rarely used in decision-making. Any actionable information is limited to recent hazard data, as opposed to a full suite of past observations and future projected climate data	Hazard/Exposure Understood: Local heat climatology is known (past, present, future distribution of heat indices); heat island influence is known (spatial pattern and extent, intensity, diurnal cycle)	Impacts Understood: Heat impact data [mortality, hospitalization, ED visits, (311 / 911 calls); cooling center usage stats; agricultural losses, labor productivity] is obtained and assessed	Relationships among drivers, impacts, and outcomes are modeled, assessed, and predicted	Real-time operational capabilities exist and actionable information is delivered to responders, health providers, and infrastructure managers in a timely manner. Data is archived and made available for assessment and research purposes

Acknowledgments

This report was developed as an output from the NOAA Heat Equity Pilot Projects funded by the NOAA Regional Collaboration Network. The Heat Equity Pilot team was composed of members from across the Line Offices of NOAA.

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NOAA National Marine Fisheries Service

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NOAA Regional Collaboration Network

- Geno Olmi, Southeast and Caribbean Regional Team (SECART)
- Aja Szumylo, West Regional Team

NOAA Office of Oceanic and Atmospheric Research

- Hunter Jones, National Integrated Heat Health Information System (NIHHIS)
- Morgan Zabow, National Integrated Heat Health Information System (NIHHIS)

NOAA National Weather Service

We would also like to thank the many National Weather Service colleagues at Weather Forecast Offices, Regional Offices, and Headquarters who co-planned and supported the execution of the activities that informed these documents.

These documents are also a product of the many local and state partners who collaborated with the NOAA team to collect citizen science heat observations, develop and run tabletop exercises, and take action after the exercises to mitigate heat in their communities. Thank you also to Maggie Allen and Lauren Balotin, NIHHIS, for final development of this document. Document design by [Luna Creative](#).