KEEP DURHAM COOL: DEVELOPMENT AND EVALUATION OF POTENTIAL HEAT ACTION PLAN FOR EXTREME HEAT IN DURHAM COUNTY

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Executive Summary

Extreme heat is the deadliest weather-related hazard in the US, creating a growing public health challenge as heat-related hospital visits and deaths increase. The built environment and available amenities greatly impact how heat is experienced on the individual and neighborhood level, and efforts to mitigate the adverse impacts have been emerging at various levels of government.

Durham County, NC is interested in establishing a heat action plan to prepare for and help mitigate the impacts of extreme heat on residents. The aim of this master's project is to develop and evaluate a potential heat action plan for Durham County. To this end, this project sought to address what the strengths and weaknesses of the selected actions are in terms of mitigating heat risk and impacts for populations who are most vulnerable to heat. Using the North Carolina Office of Recovery and Resiliency's (NCORR) 2024 Heat Action Plan Toolkit as a foundational source and building from existing initiatives in the County and case studies in other municipalities, I developed a draft heat action plan with a set of potential heat actions. The actions were evaluated through criteria from FEMA's 2023 Local Mitigation Handbook designed to assist in prioritizing mitigation strategies. Through this project, eight potential actions were developed and evaluated.

The key findings of the potential actions are:

1. **Expand the cooling center program.**
   Durham County should launch a volunteer cooling center program and focus efforts on partnerships in high vulnerability census tracts, particularly areas that are not currently within a 20-minute walk of an existing cooling center. The strengths are its focus on equitable access, its expansion from an existing program, and the availability of resources and information due to its prevalence as a heat strategy. There is limited data on use of the centers
2. **Develop a hydration station program.**
   This action involves expanding existing public water fountains in urban areas. When used, water fountains reduce heat vulnerability, bolstering people's bodies' to better manage heat stress. It serves the public but is especially crucial for unsheltered individuals, who are among the most vulnerable to extreme heat. There are installation and maintenance costs associated with this action, and the impacts are difficult to quantify.
3. **Create workplace heat standard for Durham County.**
   A heat standard would be based on voluntary OSHA (Occupational Safety and Health Administration) guidelines to reduce heat exposure for County personnel while on the

job. In addition to reduced heat risk for County personnel, the strengths of this action are that the costs are minimal and once the standard is developed, it can be implemented easily and quickly.

4. **Coordinate wellness checks and other house call visits to include heat illness prevention.**
   The County should work with social service providers and non-profits to include heat illness prevention into their existing wellness checks. This action benefits from the already existing networks of trust built through the organizations, and reduces heat risk for individuals receiving this support, who are generally more vulnerability to heat.
5. **Provide heat relief for people experiencing housing insecurity.**
   This action includes assembling heat relief provisions into kits, creating a distribution plan, and partnering with City entities and local non-profits to deliver the supplies. People experiencing housing insecurity are among the most at risk for heat mortality, yet there is a lack of studies evaluating the effectiveness of interventions on this topic.
6. **Partner with youth sports to encourage heat safety.**
   To implement this action, the County should begin by collaborating with the youth sports leagues and summer camps operated by the City's Parks and Recreation Department. Children and teens are particularly vulnerable to heat illness while playing sports, and there is substantial research, training, and guidance to assist leagues in establishing policies to reduce the adverse effects of heat in youth sports.
7. **Adopt a cooling ordinance.**
   Cooling ordinances set a requirement for homes to have cooling capabilities to a certain temperature, thereby reducing inhabitants' heat exposure. This strategy establishes regulation for habitability, which is especially impactful for renters. However, this strategy alone does not address the substantial cost of running air conditioning during extreme heat, which can be a significant barrier.
8. **Expand equitable access to green space.**
   There are efforts being made through urban forestry, tree planting, parks, and open space to expand equitable access to green space across Durham County. This action would involve streamlining an approach to measure how all the efforts are expanding equitable access to green space. Green space reduces heat risk by reducing the air temperature and providing shade and has many co-benefits. This action will take years to decades to implement and is more costly relative to other actions developed.

The draft heat action plan has strengths in that it involves actions to address the unequal exposure and vulnerability to heat across the county. The development and evaluation of heat actions provide groundwork and insight for Durham County to continue working towards extreme heat planning and mitigate adverse impacts of extreme heat on residents.

Keep Durham Cool

Development and Evaluation of Potential Heat Action Plan for Extreme Heat in Durham County

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Cover Image Data Source: Building Footprints [shapefile], Duke University.

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Introduction

Extreme heat is one of the deadliest natural hazards our country faces, and North Carolina is expected to experience increases in extreme heat as the climate continues to warm. While extreme heat remains a challenge for public health as heat-related hospital visits and deaths rise in the summer months, it is a natural hazard in which the built environment greatly affects the experience of the hazard on both an individual and neighborhood scale.[1] Resources at various levels of government are emerging to help address and prepare for extreme heat. One example is the Heat Action Plan Toolkit, launched by the North Carolina Office of Recovery and Resiliency (NCORR) and partners in April 2024, which provides documentation and information about how North Carolina municipalities can implement their own Heat Action Plans.[2]

Grounded in academic and grey literature, this master's project aims to **develop and evaluate a potential heat action plan for Durham County**. To carry out this task, I will utilize the NCORR Heat Action Toolkit as a foundation for structuring the heat action plan. I will develop actions to mitigate extreme heat based on academic and grey literature and build off the existing initiatives and work of the County. Lastly, I will evaluate the potential heat actions with FEMA's Local Mitigation criteria as a framework for prioritizing actions. In this process, I seek to answer the following questions:

1. What is the current landscape of extreme heat work and stakeholders in Durham County?

2. What are the strengths and weaknesses of the selected heat actions in terms of reducing and mitigating heat risk and impacts for populations most vulnerable to heat in Durham County?

One of my goals in this project is to create a useful report to support efforts in Durham related extreme heat. To this end, I have collaborated with Durham County's Sustainability Office and Public Health Department as a client and their expertise has shaped the direction of this project.

[1] "Durham County 2023 Community Health Assessment," Assessment, Section 11.02 (Durham County, 2023), https://healthydurham.org/wp-content/uploads/2024/03/2023-Durham-County-Community-Health-Assessment-PC.pdf.
[2] "Heat Action Plan Toolkit | ReBuild NC," accessed August 15, 2024, https://www.rebuild.nc.gov/heat-action-plan-toolkit.

Methods

The purpose of this project is to develop and evaluate a draft heat action plan for Durham County. To do this, I will use the North Carolina Office of Recovery and Resiliency's (NCORR) Heat Action Plan Toolkit as a guide for the plan structure and development. Outside of the plan, each action will be researched, highlighting background information, case study examples when relevant, and Durham context. Using the Toolkit and action research, I will develop the heat actions for Durham County, that build off existing work, projects, programs, and initiatives at the County.

The evaluation of the heat actions will be based on academic literature and FEMA's Local Hazard Mitigation Criteria. The FEMA criteria is a direction from the federal government on local hazard mitigation evaluation. It serves to assess cost and benefits; impacts and risk reduction to residents, businesses, and properties; gauge alignment with existing plans; and describes developed capacities and negative impacts to vulnerable populations from the project. Evaluating and articulating the heat actions through the lens of the FEMA criteria frames the proposed heat actions such that they can be compared with each other and potentially other hazard mitigation actions.

NCORR Heat Action Plan Toolkit

The Heat Action Plan Toolkit was developed by NCORR, the NC State Climate Office, NOAA's Carolinas Climate Adaptation Partnership, the Carolinas Collaborative on Climate, Health, and Equity, NC Department of Health and Human Services, NC Emergency Management, and the Heat Policy Innovation Hub at the Nicholas Institute for Energy, Environment and Sustainability at Duke University to assist North Carolina communities in preparing for extreme heat.[3] The concept of the Toolkit was developed from the priorities of the stakeholders at the North Carolina Regions Innovating for Strong Economies and Environment Program. The Heat Action Plan Toolkit, which includes a Heat Action Plan Template as well as recommendations, information, and tools, was launched in April 2024.

The Template opens with an introduction that outlines heat risk and impacts, the planning process, and implementation. The subsequent sections are divided up into During Heat Season, When Heat is in the Forecast, and Long-Term Strategies, each having their own timelines or thresholds that trigger the corresponding actions. Each category includes a list of suggested actions to get started and resources associated with them. Each action

[3] "Heat Action Plan Toolkit" (NCORR, April 2024), https://www.rebuild.nc.gov/heat-action-plan-toolkit.

is fleshed out with a Description, Responsible Department, Timeline, Implementation Criteria and Interval, Community Collaborators, and Metrics. The Template has suggested text and resources throughout.

I will follow the structure of the NCORR template and utilize some of the resources it provides as a starting point for the development of the actions.

Action Selection and Development

For the selection of heat actions, I consulted with Durham County officials who shared their insights on the heat-related strategies they think are most relevant for Durham.[4] Based on their input, I selected the following subset of Durham County's actions to focus on for the draft plan in the Master's Project.

During Heat Season

- Expand cooling center program.
- Develop a hydration station program.
- Create workplace heat standard for Durham County.

When Heat is in the Forecast

- Coordinate wellness checks and other house call visits to include heat illness prevention.
- Provide heat relief for people experiencing housing insecurity.
- Partner with youth sports to encourage heat safety.

Long Term Strategies

- Pass a cooling ordinance.
- Expand equitable access to green space.

Using the Template, action research, and information on the local context, I will develop draft heat actions for Durham County. The actions will build on the existing work that the County does or has initiated. The development of the actions will focus on the description -- communicating what activities are encompassed in carrying out the action, and metrics.

After the plan is developed, I will analyze the actions through academic and gray literature to provide further local context, detail, and case study examples that contextualize the selected action.

[4] Tobin Freid and Corey Morris, Collaboration with Durham County, virtual, n.d.

Since the data utilized in this project is primarily academic and gray literature and quantitative data, there is a lack of community engagement and collaboration that is typically present in a planning process. Community engagement and feedback is an important component of any planning process; however, it is not within the scope of this plan development. As a result, I will primarily omit the components describing community opinion or collaboration in this plan. The focus of this draft plan will be on the development of heat action's description and metrics associated with them.

FEMA Local Hazard Mitigation Criteria

FEMA's 2023 Local Mitigation Handbook is designed for local governments to use for their hazard mitigation plans.[5] The handbook details tasks of the planning process and the associated recommendations and advice for carrying out each step. The FEMA handbook recommends assessing and prioritizing actions by an agreed set of criteria. This project will look at the following categories:

- Risks and Impacts: this section will assess the broad risks and impacts of the action including how the action affects residents (related to the FEMA criteria of life and safety)
- Strengths, Benefits, and Equity: will focus on the strengths of the action and include an assessment of its equity and the avoided losses and qualitative benefits of the action
- Weaknesses and Barriers: this section will describe the obstacles to implementing the action and the weaknesses of the action as a strategy
- Continuity with other plans: will describe how this action is aligned with other plans

The FEMA handbook recommends evaluating more criteria, being technical and cost components. I have excluded these from my analysis. I will be outlining the benefits and cost/barriers of each action broadly but will not formulate a full cost-benefit analysis of each action.

[5] "Local Mitigation Planning Handbook | FEMA.Gov," March 25, 2024, https://www.fema.gov/emergency-managers/practitioners/recovery-resilience-resource-library/local-mitigation-planning.

Background

Extreme Heat Overview

Extreme heat, as defined by the US government's ready.gov website, is "a period of high heat and humidity with temperatures above 90 degrees for at least two to three days."[6] Extreme heat challenges our bodies' ability to keep a stable temperature, creating the risk of illness or death. Each year, heat is the top killer relative to all other weather events, yet heat death and illness is often considered preventable by limiting exposure.

The effects of extreme heat create mounting public health challenges. Studies continue to demonstrate the negative effects of heat stress on the elderly, young children, pregnant people, and people with chronic illnesses across geographies.[7] Heat stress can lower motor and cognitive functions, affecting work capacity and productivity for the more than 1 billion people across the globe who are exposed to extreme heat in their employment.[8] Many communications about extreme heat for public audiences, such as those found on heat.gov, highlight actions and strategies for individuals to take during a heatwave and educational materials to build awareness of heat illnesses such as heat cramps, heat exhaustion, and heat stroke [9].

On a global scale, the frequency and severity of extreme heat has increased over the last 75 years, with the primary cause being anthropogenic climate change.[10] Since 1960, the largest American cities have experienced an increase in the average number of annual extreme heat events from 2.04 to 6.02, an increase in minimum daily temperature, and an increase in the mean duration of the heatwaves from 2.98 days to 3.96 days.[11] With any emission scenario, average yearly temperatures are forecasted to increase approximately

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[6] "Extreme Heat | Ready.Gov," accessed August 17, 2024, https://www.ready.gov/heat.
[7] Kristie L. Ebi et al., "Hot Weather and Heat Extremes: Health Risks," *The Lancet* 398, no. 10301 (August 21, 2021): 698–708, https://doi.org/10.1016/S0140-6736(21)01208-3.
[8] Ebi et al.
[9] "HEAT.Gov - National Integrated Heat Health Information System," accessed August 17, 2024, https://www.heat.gov/.
[10] Intergovernmental Panel On Climate Change (Ipcc), *Climate Change 2021 – The Physical Science Basis: Working Group I Contribution to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change*, 1st ed. (Cambridge University Press, 2023), https://doi.org/10.1017/9781009157896.
[11] Zachary Kearl and Jason Vogel, "Urban Extreme Heat, Climate Change, and Saving Lives: Lessons from Washington State," *Urban Climate* 47 (January 1, 2023): 101392, https://doi.org/10.1016/j.uclim.2022.101392.

2.5°F across the continental US over the coming decades, and between 3°F and 12°F by the year 2100.[12]

Federal and State Governments' Engagement with Extreme Heat

There has been growing attention at the federal level on extreme heat and mitigating its impacts, as evidenced by the release of the first ever National Heat Strategy 2024-2030 and extensive heat.gov website maintained by the National Integrated Heat Health Information System.[13] FEMA support and resources in response to a major disaster are enabled through the President agreeing to a Stafford Act Declaration.[14] Disasters are evaluated on a case-by-case basis, and despite federal efforts made on some fronts, extreme heat events have never received a Stafford Act Declaration. As recently as 2022, California was rejected for a Declaration request for the 'heat dome' and fires it was experiencing. FEMA communicated their evaluation of the request to be for the fires, and not extreme heat, and that "FEMA precedent is to evaluate discrete events and impacts, not seasonal or general atmospheric conditions".[15] Although each time a governor has requested federal support, it has been denied, FEMA insists that extreme heat is eligible for FEMA assistance through the Stafford Act as is despite there being no precedent for it. In 2023, the FEMA Administrator gave Congressional testimony stating, "The Stafford Act does not need to be amended to include extreme heat. We base our decisions on a number of factors. Mostly on, does it exceed the capacity of the state and local jurisdictions?"[16] Regardless, an Arizona Congressman introduced a bill titled *Extreme Heat Emergency Act of 2023* in June 2023, which would explicitly add extreme heat to the definition of major disaster in the Safford Act.[17] This bill, with bipartisan support and a cosponsor from a North

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[12] USGCRP, "Fourth National Climate Assessment" (U.S. Global Change Research Program, Washington, DC, 2018), https://nca2018.globalchange.govhttps://nca2018.globalchange.gov/chapter/2.

[13] "HEAT.Gov - National Integrated Heat Health Information System."

[14] Erica Lee and Bruce Lindsay, "Stafford Act Declarations for Extreme Heat" (Congressional Research Service, June 20, 2024), https://crsreports.congress.gov/product/pdf/IN/IN12384/1.

[15] "Stafford Act Declarations for Extreme Heat" (Congressional Research Service, June 20, 2024), https://crsreports.congress.gov/product/pdf/IN/IN12384.

[16] "FEMA: The Current State of Disaster Readiness, Response, and Recovery | Transportation and Infrastructure Committee," Committee on Transportation & Infrastructure, September 19, 2023, https://transportation.house.gov/calendar/eventsingle.aspx?EventID=406854.

[17] Ruben [D-AZ-3 Rep. Gallego, "All Info - H.R.3965 - 118th Congress (2023-2024): Extreme Heat Emergency Act of 2023," legislation, June 12, 2023, 2023-06-09, https://www.congress.gov/bill/118th-congress/house-bill/3965/all-info.

Carolina Representative, is sitting in a subcommittee as of 2023. As the second Trump Administration begins, the President has suggested that FEMA be significantly restructured, and disaster management be governed by the states.[18]

At the state level in North Carolina, there are notable initiatives addressing extreme heat, these include the Heat Action Plan Toolkit, the Heat Health Alert System, and Operation Fan Heat Relief.[19]

The NC Office of Resilience and Recovery led the development of the Heat Action Plan Toolkit, which provides guidance, templates, and resources for local governments to make heat action plans in North Carolina.[20] Contrary to the federal government's definition of extreme heat, 2-3 days of high temperatures and humidity over 90°F, Heat Action Plan Toolkit indicates that extreme heat happens when temperatures exceed a context-specific heat threshold based on historic data, time of year, local conditions and population. For Durham County, the threshold is a heat index of 100°F.[21] Since government agencies have varying definitions of extreme heat and extreme heat events, determining and clearly articulating the definition being utilized becomes imperative.

The Heat Health Alert System, based in the NC Department of Health and Human Services (NCDHHS), is a state-wide voluntary warning system for which residents can sign up to receive email notifications if their county is projected to exceed heat thresholds.[22] Primarily targeting elderly people, NCDHHS also highlights senior centers in each county across the state that provide fans to individuals during the summer months.[23]

The experience, exposure, and vulnerability to extreme heat vary significantly across geographies, populations, and within the same city. While federal and state governments may provide some support for extreme heat mitigation initiatives, local governments are

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[18] Asma Khalid, "Trump Says He Wants to Overhaul FEMA as He Travels to North Carolina and California," *NPR*, January 24, 2025, sec. Politics, https://www.npr.org/2025/01/24/nx-s1-5273606/trump-visit-asheville-california-disasters.
[19] "Heat Action Plan Toolkit"; "NCDHHS: DPH: Epidemiology: OEE: Summer Heat Emergency Data and Prevention Tips," accessed August 18, 2024, https://epi.dph.ncdhhs.gov/oee/climate/heat.html; "Operation Fan Heat Relief | NCDHHS," accessed August 18, 2024, https://www.ncdhhs.gov/divisions/aging/operation-fan-heat-relief.
[20] "Heat Action Plan Toolkit."
[21] "Heat Action Plan Toolkit."
[22] "NCDHHS: DPH: Epidemiology: OEE: Summer Heat Emergency Data and Prevention Tips."
[23] "Operation Fan Heat Relief | NCDHHS."

well positioned to address impacts of extreme heat and take context-specific action unique to their jurisdiction and residents.

Extreme Heat Efforts in Durham County

The Triangle Regional Resilience Assessment Technical Report (2018), the Eno-Haw Regional Hazard Mitigation Plan (2020), and the Durham County Community Health Assessment (2023) are the primary municipal documents that are relevant to extreme heat in Durham County. The Triangle Regional Resilience Assessment details the regional vulnerabilities, adaptive capacities, and impacts of extreme heat on emergency services, energy and utilities, food infrastructure, hospitals, public health, and government buildings.[24] The Eno-Haw Regional Hazard Mitigation Plan assesses regional hazards, including extreme heat, and finds it to be 'highly likely' with critical impacts, and uses heat index as the primary metric of interest.[25]

The 2023 Durham County Community Health Assessment covers extreme heat. Among other data, it describes the current and projected increase in nighttime temperatures, the projected days per year above 95°F, and the community mapping campaign in 2021 that showed a more than 10°F temperature difference across the city of Durham. The data in this report accounts for different climate scenarios, identifies factors that may increase an individual's vulnerability to extreme heat, and describes the different dynamics of rural and urban heat experiences. This report details how the lasting impacts of redlining, historic divestment, and systemic racism have resulted in higher exposure and vulnerability to heat for residents of those census tracts. The section concludes with recommendations that includes implementing a heat action plan, adopting an indoor maximum temperature, and creating equitable green space.[26]

In addition to existing plans and reports, there are other local stakeholders doing work on extreme heat in Durham. The City of Durham's urban forestry program has an equity focus for tree planting.[27] The Museum of Life and Science, a well-established non-

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[24] "Resilience Assessment," Technical Report (Triangle Regional Resilience Partnership, October 2018), https://www.centralpinesnc.gov/sites/default/files/uploads/trrp_report_technicalreport_102418.pdf.

[25] "Eno-Haw Regional Hazard Mitigation Plan," September 2020, https://www.orangecountync.gov/DocumentCenter/View/19321/Eno-Haw-Final-Hazard-Mitigation-Plan-PDF.

[26] "Durham County 2023 Community Health Assessment."

[27] "Urban Forest Management Plan" (Durham: City of Durham, 2018), https://www.durhamnc.gov/DocumentCenter/View/44429/UF-Management-Plan?bidId=.

profit museum in Durham, received a $2.3 million grant from the National Oceanic and Atmospheric Administration in 2024 to create a Center for Collaborative Heat Monitoring that will work with partnering sites across the country on extreme heat community science and data.[28] Duke's Nicholas Institute's Heat Policy Innovation Hub builds partnerships, collaborates with experts and stakeholders, and conducts research to shape extreme heat policy across the US. They were partners in the Heat Action Toolkit, contributing writers to the 2023 Durham County Community Health Assessment, and provide resources and publications concerning heat.[29]

In the Durham County Community Health Assessment, the first listed recommended strategy is for mitigating extreme heat is "Develop and adopt a heat action plan outlining protocols and strategies for a timely and appropriate response when dangerous heat is forecasted." [30] Additionally, the County Sustainability Office website showcases efforts made around urban heat islands and the County Public Health Department's Public Health Preparedness website details information on cooling centers and heat illnesses.[31]

Understanding exposure and vulnerability to heat is vital to supporting Durham County in its efforts to build local capacity to address extreme heat.

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[28] "RELEASE: Museum of Life and Science to Receive $2.3 Million to Create NIHHIS Heat Monitoring Center," Museum of Life and Science, May 20, 2024, https://www.lifeandscience.org/blog/release/release-museum-of-life-and-science-to-receive-2-3-million-to-create-nihhis-heat-monitoring-center/.
[29] "Heat Policy Innovation Hub," August 15, 2024, https://nicholasinstitute.duke.edu/project/heat-policy-innovation-hub.
[30] "Durham County 2023 Community Health Assessment."
[31] "Extreme Heat and Urban Heat Islands | Durham County," accessed January 25, 2025, https://www.dconc.gov/county-departments/departments-a-e/engineering-and-environmental-services/sustainability-office/climate-resilience/extreme-heat; "Public Health Preparedness | Durham County - NC - Public Health," accessed January 25, 2025, https://www.dcopublichealth.org/services/environmental-health/public-health-preparedness.

Heat Exposure and Vulnerability in Durham County

Heat Exposure in Durham County. On July 23, 2021, an Urban Heat Island Temperature Mapping Campaign equipped volunteers in both Raleigh and Durham with temperature and humidity monitors to collect data in different neighborhoods across the city.[32] The study was made possible through a partnership of Durham County with the NC Climate Office, Activate Good, and other partners. The maps generated from this study highlighted the different experiences of heat across the cities on this day. Between 3-4pm, Durham's highest recorded temperature was 88.3°F, while other parts of the city were recorded to be 80.2°F at the same time. However, the highest temperature difference of 10.4 degrees happened between 7 and 8pm, after people have experienced the heat of the day and are in need of cooling down. Although a weather report may only give a single temperature for the city, this study highlights that people across an urban area experience heat differently.

[32] "Urban Heat Island Temperature Mapping Campaign - North Carolina State Climate Office," March 18, 2021, https://climate.ncsu.edu/research/uhi/.

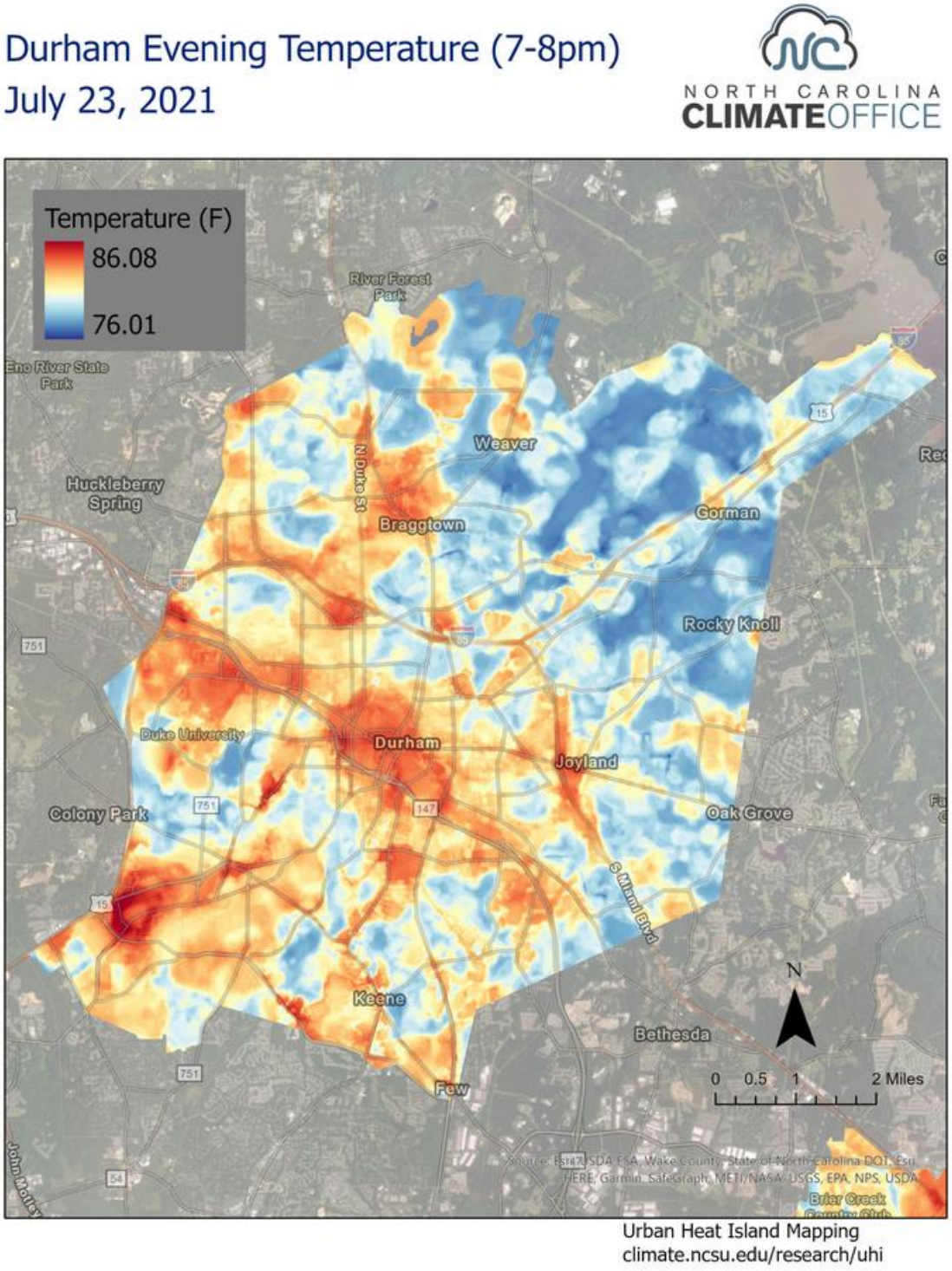


Figure 1. Map of Durham temperature 3-4pm on July 23, 2021. Source: NC State Climate Office, 2021.

Heat Vulnerability. The NCORR Toolkit describes that all people feel the effects of extreme heat; however, some populations are more vulnerable to it.[33] NCORR and the Durham CHA recognize that the following populations have health, social, or economic conditions that increase their vulnerability to extreme heat:

- Newborns and young children
- Pregnant people
- Individuals on medications that affect body temperature
- Adults 65 years or older
- Employees working outside
- Low-income people
- People with chronic illnesses or physical disabilities
- Athletes of all ages
- People who are isolated
- People who are obese
- People who experience workplace heat exposure

While many heat vulnerability indicators and indices exist (e.g., NYC[34], Philadelphia[35], Richmond Indiana[36]), this project utilizes the CDC/ASTR's Social Vulnerability Index (SVI) because it is broadly used and well-accepted in hazard vulnerability assessments.

SVI is an index that quantifies vulnerability to disasters on a census tract or county level. It does not incorporate any direct hazard data but rather uses 16 Census variables that make up four categories (socioeconomic factors, household traits, race and ethnicity, and house type and transportation). The SVI communicates a social vulnerability metric that is relative to census tracts across the US, and it is not exhaustive of all aspects of vulnerability. The variables SVI includes are:

- Below 150% poverty
- Unemployed
- Husing cost burden
- No high school diploma
- No health insurance
- 65 years or older
- 17 years or younger
- Civilian with a disability
- Single-parent households
- English language proficiency
- Race and ethnicity
- Multi-unit housing structures
- Mobile homes
- Crowding
- Lack of vehicle
- Group quarters

[33] "Heat Action Plan Toolkit."
[34] "Interactive Heat Vulnerability Index.," Environment & Health Data Portal, accessed November 23, 2024, https://a816-dohbesp.nyc.gov/IndicatorPublic/data-features/hvi/.
[35] "Philadelphia Heat Vulnerability Index," accessed February 7, 2025, https://phl.maps.arcgis.com/apps/webappviewer/index.html?id=9ef74cdc0c83455c9df031c868083efd.
[36] "Richmond Heat Management Plan-May 2023," accessed February 7, 2025, https://portal.laserfiche.com/Portal/DocView.aspx?id=177782&repo=r-979ae874&preview=ZzbKa7B.

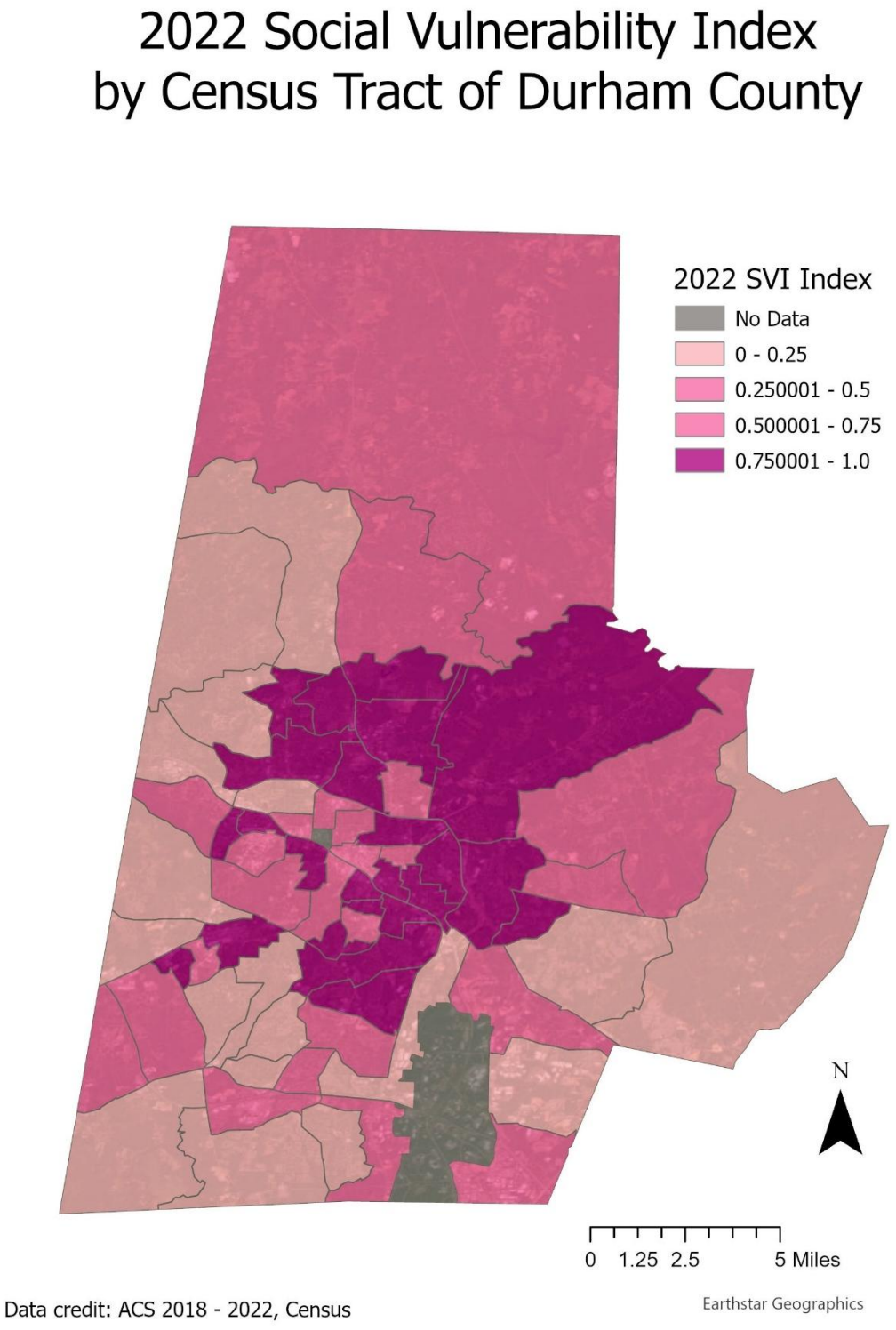


Figure 2. Map of 2022 Social Vulnerability Index by Census Tract of Durham County. Data Source: CDC/ASTDR. Map made by author using ESRI ArcGIS Pro.

Draft Durham County Heat Action Plan

Adapted from the NCORR Template and the NCORR Heat Planning Cohort

Introduction

Durham County experiences hot and humid weather in the warm months of the year, creating a challenge for public health as heat-related hospital visits and deaths rise. Residents who have higher vulnerability or higher exposure to extreme heat are more likely to experience heat-related symptoms, illness, or death.

A heat action plan is important for planning and taking action to mitigate the effects of extreme heat in the Durham community.

The mission of **Durham County's Heat Action Plan** is to describe a set of strategic actions for the County and its collaborators to equitably equip residents for extreme heat. This plan seeks to create the following outcomes:

1. Educate the public about extreme heat and its effects
2. Describe heat-related amenities available in Durham County
3. Decrease heat illness and death

The Heat Action Plan is structured such that the actions encompassed in During Heat Season are activated on May 1st, the first day of heat season, or the first day with a maximum temperature of 85°F. Actions included in When Heat is in the Forecast are activated when the heat index is 100°F. Finally, the section on Long-Term Strategies includes actions and projects that may operate on a multi-year scale.

Table 1. Historic and projected maximum temperatures for Durham County.
Source: NC Resilience Exchange [37], Adapted from NCORR Heat Planning Cohort 2025.

Days with Max Temps of 95°F or Greater	
Between 1983 and 2014, on average, Durham County experienced: **9 days per year**	By the 2060s, on average, Durham County will experience: **32 to 45 days per year**
Days with Max Temps of 90°F or Greater	
Between 1983 and 2014, on average, Durham County experienced: **42 days per year**	By the 2060s, Durham County will experience: **78 to 92 days per year**
Nights with Max Temps of 70°F or Greater	
Between 1983 and 2014, on average, Durham County experienced: **22 nights per year**	By the 2060s, Durham County will experience: **53 to 70 nights per year**

[37] "Climate Projections | NC Resilience Exchange," accessed March 7, 2025, https://www.resilienceexchange.nc.gov/understand-your-vulnerabilities/climate-observations-and-projections.

Heat varies across geographies, micro-climates, and even across streets. The following map, Figure 3, displays heat anomalies. The heat anomalies are quantified by the relative surface temperatures compared to the city of Durham's average temperature, however, the dataset does not provide the absolute temperature range throughout the area. Generally red represents hotter areas and blue for the cooler areas.

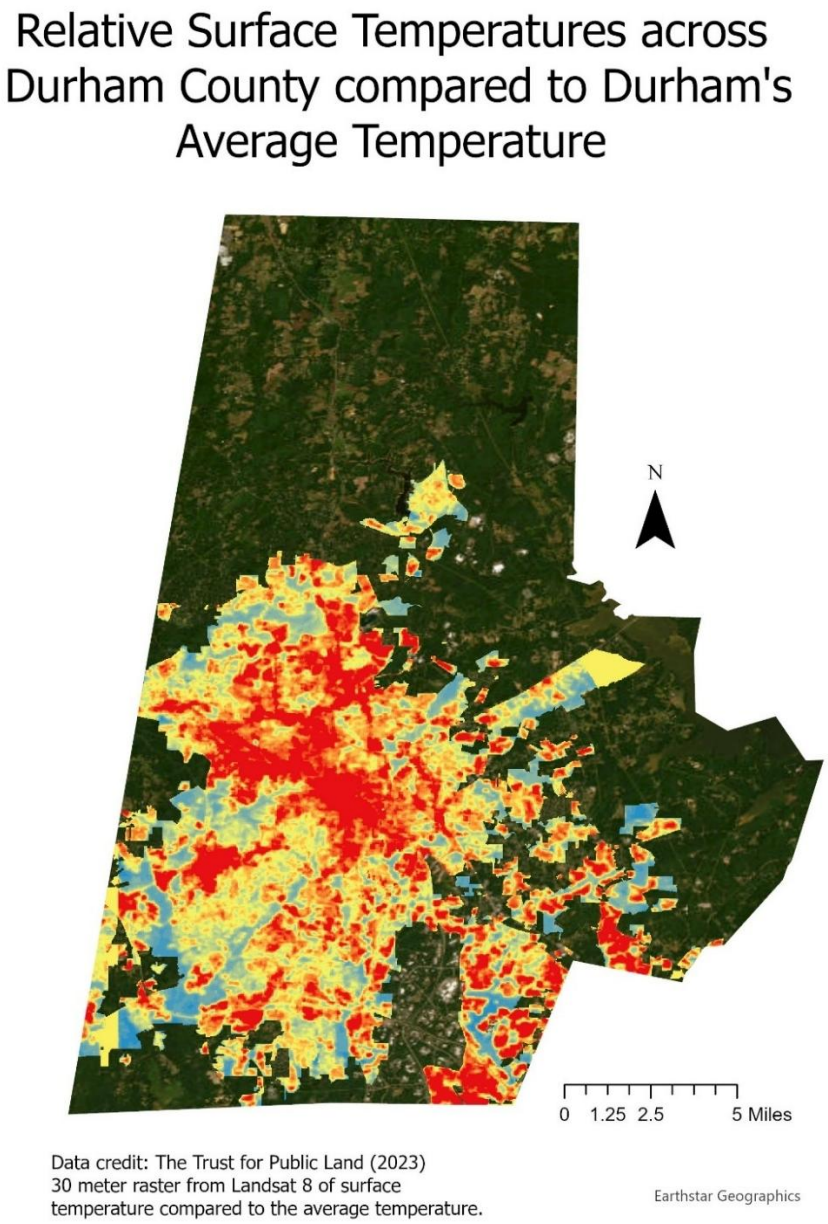


Figure 3. Mapping heterogeneous surface temperatures across Durham County, demonstrating heterogeneous and inequitable heat exposure.

Heat Vulnerability:

Heat affects everyone, but there are qualities that can make some people more susceptible to the impacts of heat. The following populations have health, social, or economic conditions that increase their vulnerability to extreme heat:

- Newborns and young children
- Pregnant people
- Individuals on medications that affect body temperature
- Adults 65 years or older
- Employees working outside
- Low-income people
- People with chronic illnesses
- Athletes of all ages

Urban heat islands have a direct legacy from redlining and systemic racism, which created neighborhoods that have higher percentages of people of color, residents in poverty, more heat-trapping impervious surface, and less green space. Residents who have less access to cooling, whether through unaffordable AC costs or outdoor work, have more exposure to extreme heat and its impacts.

The actions of this plan aim to direct heat mitigating amenities and projects to be equitably distributed across Durham County and respond to the unique needs of our community.

To assess vulnerability in this plan, the CDC/ASTDR's Social Vulnerability Index at the census tract level will be utilized. Census tracts with an SVI rating of 0.75 or higher are considered areas with the highest vulnerability to the impacts of extreme heat. Figure 3 displays the SVI by census tract in Durham County with a dark outline around the census tracts with the highest SVI (between 0.75 and 1).

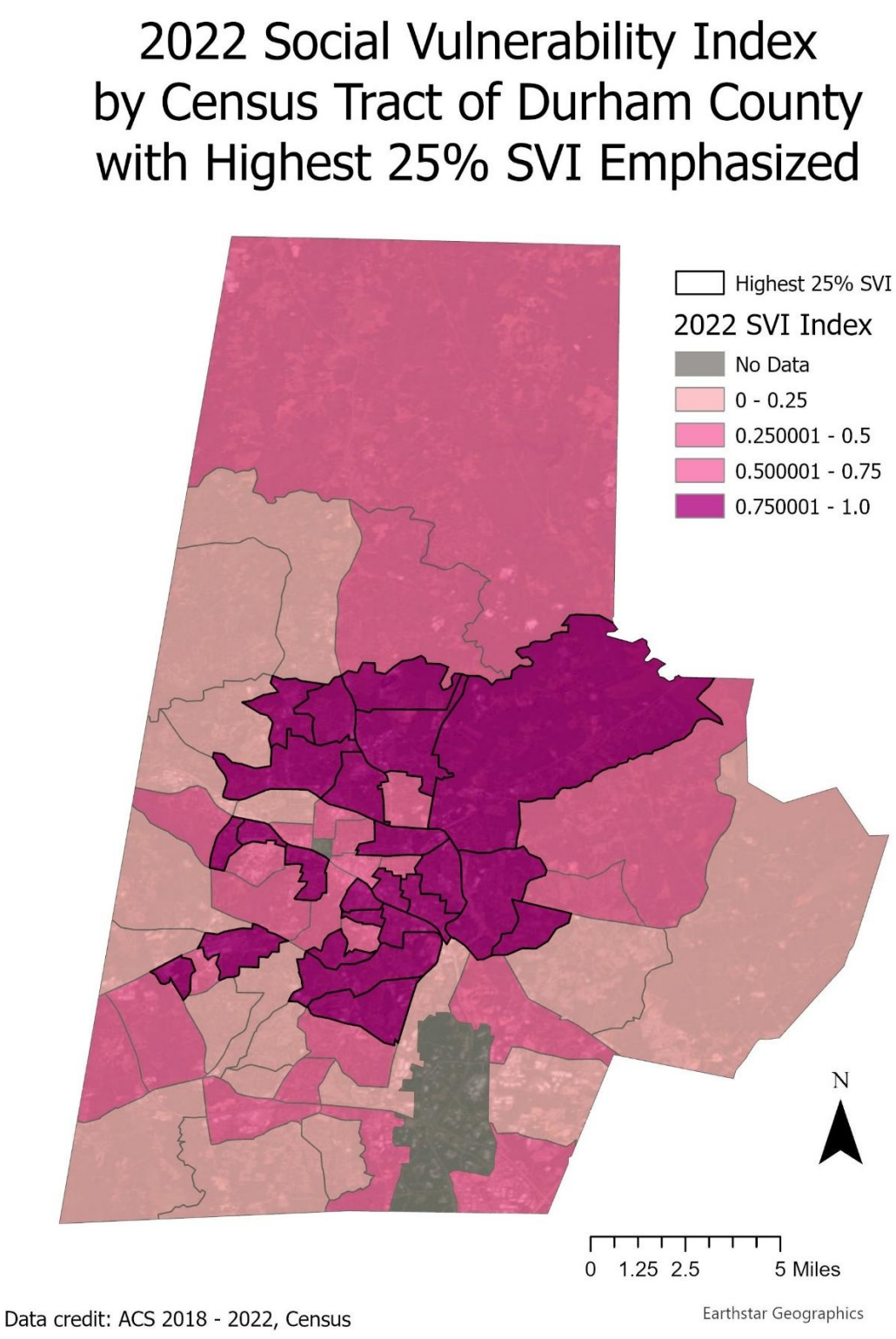
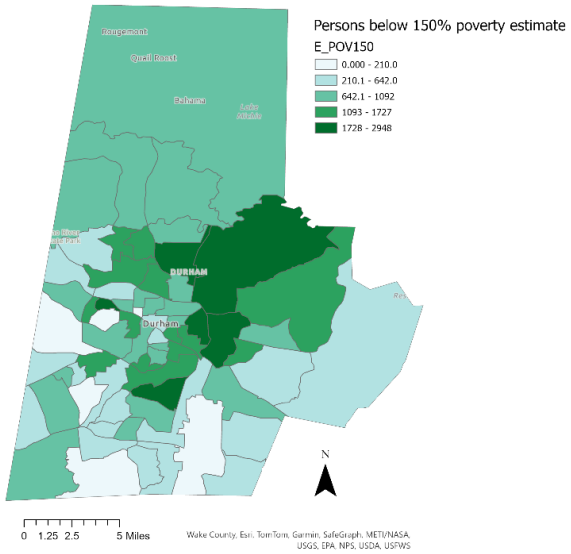


Figure 4. Map of 2022 Social Vulnerability Index by Census Tract in Durham County, highlighting census tracts with highest SVI.

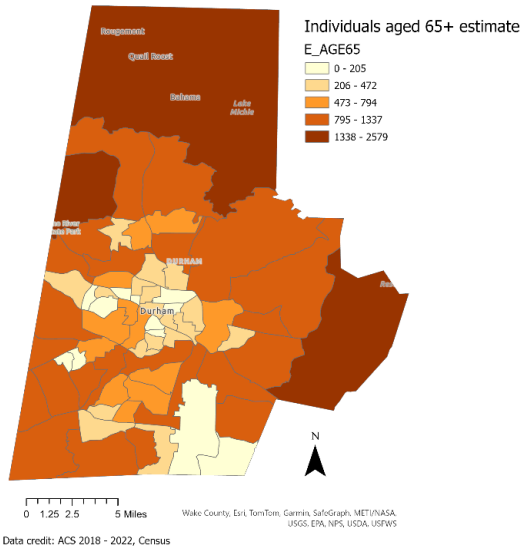
Heat-Related Demographics and Characteristics by Census Tract in Durham County

The following maps illustrate demographic traits of Durham County that are relative to heat vulnerability. They include population below 150% of the poverty line, the percentage of older adults, the percentage of people of color, and the population density by census tract.

Count of Individuals below 150% Poverty Estimate in Durham County

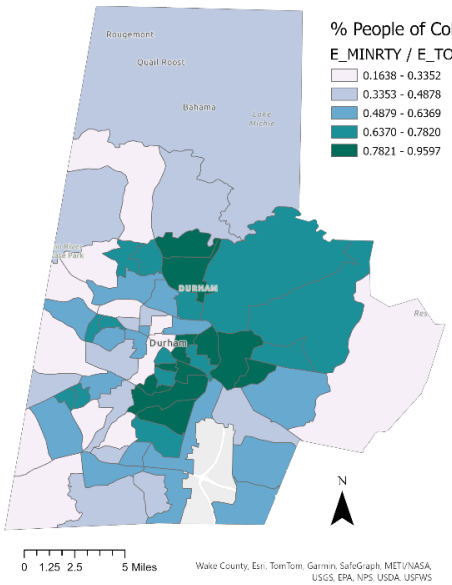


Estimated Count of Individuals Aged 65 and older in Durham County



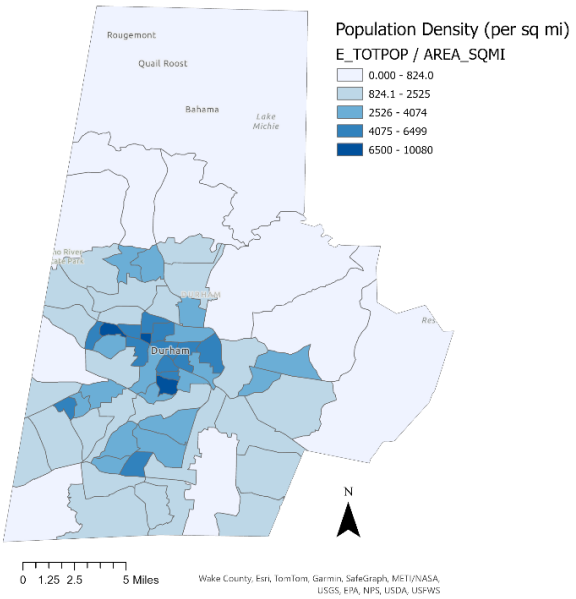
Data credit: ACS 2018 - 2022, Census

Percentage of People of Color in Census Tracts in Durham County



Data credit: ACS 2018 - 2022, Census

Population Density of Census Tracts in Durham County



Data credit: SVI 2022

Part I: During Heat Season

The actions in this section are in preparation for heat season.

Heat season begins on May 1 or the first day of 85°F temperatures and ends on September 30th, or the last day to be 85°F. The table below details the historic monthly average minimum and maximum temperatures over a recent 30-year period.

Average Monthly Maximum and Minimum Air Temperatures for Durham, NC from 1991 – 2020, in °Fahrenheit [38]

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Max	48.9	52.5	60.7	70.3	76.6	83.3	87.0	84.6	79.3	69.5	60.0	52.1
Min	27.9	30.3	37.2	46.0	55.4	64.2	68.8	67.2	60.9	48.0	37.1	32.2

Temperature thresholds that are associated with public health impacts provide more insight into extreme temperatures experienced in Durham County. The table below compares the max air temperature and max heat index at the Durham Scout Station located downtown.

Heat index is a measure of air temperature and humidity, indicating a 'feels like' temperature.

Average First and Last Date When Threshold is Exceeded for Durham County

	First Date					***Last Date***				
	85 °F	90 °F	95 °F	100 °F	105 °F	85 °F	90 °F	95 °F	100 °F	105 °F
Max Air Temperature	April 7	May 10	June 14	July 22	June 29	Oct 14	Sept 21	Sept 5	Aug 8	July 8
Max Heat Index	April 20	May 17	June 5	Jun 26	Jul 8	Oct 15	Sep 26	Sep 14	Aug 28	Aug 7

Data: North Carolina State Climate Office, North Durham Water Reclamation Facility Scout Station. [39]

[38] "NOAA NCEI U.S. Climate Normals Quick Access," accessed February 7, 2025, https://www.ncei.noaa.gov/access/us-climate-normals/.
[39] "Station Scout – Products | North Carolina State Climate Office," accessed February 7, 2025, https://products.climate.ncsu.edu/cardinal/scout/.

Expand cooling center program.

Cooling centers are public or privately-owned spaces with air-conditioning that provide people with relief from the heat.

Current Cooling Center Program in Durham:

- Durham County activates and advertises the county libraries as cooling centers as needed.

Description of Activities:

- Develop a guide and documentation on "How to Manage a Cooling Center" and launch a volunteer cooling center program that equips participating organizations with resources to serve as a cooling center.
- Expand access to cooling centers in high vulnerability areas (having an SVI of 0.75 or higher), assessing existing sites with a 15-minute walking network analysis. Partner with faith-based organizations, non-profits, senior centers, and other organizations (private, public, and non-profit) to provide cooling amenities, especially in areas that lack them.
- Evaluate the effectiveness of existing cooling centers.

Project Metrics:

- Count of cooling center visitors
- Count of new cooling centers launched each year
- Average number of person-hours spent at cooling centers
- Percent coverage of high-SVI areas with 15-minute walk to cooling centers

Develop a hydration station program.

Hydration stations are locations where people can access drinking water. They can be inside or outside and provide water through fountains and refill spouts or bottled water.

Current Hydration Stations in Durham:

- H2O 2 Go Hydration Station: is a mobile hydration station that can be reserved for large public events. It provides 8 drinking fountains and 8 refill spouts to keep people hydrated at large events during the warm months.
- Durham Parks and Recreation Facilities: A total of 51 facilities operated by Durham Parks and Recreation have water fountain amenities available.

Description of Activities:

Develop and deploy a pilot program for seasonal water fountains to be continuously publicly accessible during heat season. Seasonal water fountains should be located in priority areas, which have a combination of higher social vulnerability, high heat exposure, higher population density, and longer distances to existing drinking water amenities.

Project Metrics:

- Number of water fountains installed
- Count of uses of H2O 2 Go hydration station
- Number of uses per water fountain during heat season
- Percentage of surveyed users who view hydration stations positively, negatively, and neutrally

Create a workplace heat exposure standard for county personnel.

A workplace heat exposure standard is an internal policy that aims to mitigate heat exposure and impacts for personnel. This policy is specific to Durham County employees only.

Current Workplace Heat Exposure Standard:

- None

Description of Activities:

- Identify relevant components of voluntary heat illness prevention documentation, plans, and training from both state and federal level OSHA.
- Co-produce a workplace heat exposure standard with managing and affected personnel. Consider policies for supplying water and shade, acclimatizing employees to heat, assessing extreme heat conditions, responding to extreme heat events and emergencies, heat training, and responding to employees who are actively experiencing heat illness.
- Develop a pilot of the policy and evaluate impacts and effectiveness with participating personnel.

Project Metrics:

- Before/after comparison of heat symptoms or illness reported
- Survey of personnel perception

Part II: When Heat is in the Forecast

Distribute heat relief provisions for people facing housing insecurity.

People facing housing insecurity have high exposure and vulnerability to extreme heat. Providing provisions to these residents when extreme heat is in the forecast may help to mitigate heat injury, illness, and death.

Current efforts:

- Durham Rescue Mission offers 'Operation Cool Shelter' during the summer heat to distribute some provisions and provide transportation to shelters

Description of Activities:

- Collect and assemble heat relief provisions into kits. Kits should include items from each category:
    - Hydration: water, electrolytes, insulated water bottles, water container for pets
    - Sun relief: sunblock, hats, umbrellas, sunglasses
    - Cooling provisions: towels/bandanas, battery-powered personal fans, aloe lotion/gel, socks, cold packs
    - Communication/Information: literature on heat illness prevention, cooling center information, and other appropriate heat mitigation services available
- Determine who, where, and how provisions will be distributed.
- Collaborate with the City's Continuum of Care and HEART response teams, and non-profits such as Urban Ministries of Durham and the Durham Rescue Mission to deliver heat relief provisions.

Project Metrics:

- Count of kits distributed
- Count of people benefitting from kits if distribution varies from one kit per individual

Partner with youth sports to encourage heat safety.

Youth are more vulnerable to heat because their bodies are less efficient than adults at managing heat and take more time to acclimatize to hotter temperatures. Youth may not be aware of their hydration or thermal comforts, often depending on adults or caretakers to manage it for them. Through sports, school, and other activities, children and teens have more exposure to heat, and when playing sports, their exertion exacerbates their vulnerability to heat illness.

Current youth sports heat safety in Durham:

- DPR's Ropes Discovery Course has language related to extreme heat in the FAQs: "Extreme heat (95 degrees+), cold, wind and dangerous storm conditions which endanger the safety of the participant may result in the postponement or cancellation of the program."

Description of Activities:

- Collaborate with Durham Parks and Recreation providing youth sports leagues and summer camps (YMCA of the Triangle and others) to integrate heat safety considerations in sports. Considerations in the policy may include:
    - Heat monitoring and thresholds for program changes (application to indoor and outdoor sports)
    - Acclimatization protocols
    - Schedule of breaks with access to shade and water
    - Training for personnel to recognize heat illness
    - Emergency Action Plan in place for response

Project Metrics:

- Number of programs utilizing heat considerations
- Number of youths registered for programs utilizing heat considerations
- Number of staff members trained
- Number of days per site monitored

Coordinate wellness checks and other house call visits to include heat illness prevention.

Providing resources and training on heat illness prevention to entities that are already carrying out wellness checks can help to support residents who are older, have chronic illnesses or limited mobility, or are socially isolated in extreme heat events.

Current wellness checks in Durham:

- Durham County Social Services Department offers the In-Home Aide, Home Delivered Meals Services, and In-Home Special Assistance involving home visits
- Meals on Wheels Durham provides meal delivery services, wellness calls, and other programming to hundreds of residents of Durham County. In 2024, they delivered more than 200 fans to older residents to mitigate the effects of extreme heat.

Description of Activities:

- Develop Durham-specific heat related training and communication for in-home wellness checks
- Provide resources and training on heat illness prevention to entities who already conduct wellness checks
- Meet with collaborators prior to heat season to prepare and share resources and training. After heat season, evaluate successes, gaps, and further developments of heat illness prevention component of wellness checks.

Project Metrics:

- Number of wellness calls including heat illness prevention
- Number of individuals per household benefitting from wellness calls that include heat illness prevention

Part III: Long Term Strategies

Pass a cooling ordinance.

A cooling ordinance is a law enacted to set a maximum indoor temperature threshold in certain residential buildings. It may be activated under certain circumstances, such as during the heat season or when the heat index reaches a certain temperature, or active at all times.

Current Cooling Ordinance:

- None

Description of Activities:

- Collaborate with Durham County Public Health Department, North Carolina State Department of Health and Human Services, and other extreme heat stakeholders to investigate and recommend a maximum indoor temperature threshold for residential buildings.
- Determine:
    - Which residential buildings (existing, new construction, renter-occupied, etc.) will be subject to the ordinance and which may be excluded
    - Any activation criteria for when the cooling requirements are in effect
    - Proposed phases of implementation
    - Policy enforcement procedures
    - Any incentivizes
- County staff draft a cooling ordinance and engage renters, homeowners, public health practitioners, landlords, and other stakeholders for feedback.
- Review and adoption of amended cooling ordinance by the Board of County Commissioners.

Project Metrics:

- Count of violations of cooling ordinance over time
- Long term reduction in heat-related emergency department visits as analyzed by the NC Department of Health and Human Services[40]

[40] "NCDHHS: DPH: Epidemiology: OEE: Summer Heat Emergency Data and Prevention Tips."

Expand equitable access to green space.

Through their natural processes, plants cool the air temperature in their immediate surroundings and can provide shade. Durham aims to expand equitable access to green space through efforts in parks, tree canopy, open space, and tree giveaways in neighborhoods with lower tree canopy coverage and less access to parks and green space.

Current equitable green space initiatives:

- City of Durham's Department of Parks and Recreation recognizes the inequitable access to parks across the city due to the location and types of parks being uneven across the city. They are making efforts to improve residents' access
- City of Durham's Urban Forestry Program plants 85% of new trees in high priority areas, which are determined by several qualities including low tree canopy coverage, vulnerability of residents, and heat intensity
- Keep Durham Beautiful is a local non-profit that facilitates tree giveaways and tree plantings in neighborhoods with low tree canopy coverage
- Durham Open Space Program works towards land preservation and has considerations for the cooling provided by green space

Description of Activities:

- Continue working towards expanding equitable access to green space through existing channels
- Streamlining an approach to describe and measure how all the initiatives are expanding equitable access to green space, highlighting the co-benefits
- Share information and strategies on plant species choice and planting locations among local collaborators working on equitable green space access

Project Metrics:

- Number of trees planted
- Canopy coverage in low canopy neighborhoods relative to average Durham County canopy

Plan Evaluation

Expand cooling center program.

Action Analysis through Literature and Durham Context

Indoor air conditioning mitigates heat-related fatalities and injuries.[41] Cooling centers, which the NCORR Template defines as "air-conditioned indoor locations intended to provide refuge to people (and pets, when possible) from the heat during the day," can be activated as a response to extreme heat seasons and events. [42]

Cooling centers can take many forms, be it private or public facilities. To develop a cooling center program as a coordinated response to extreme heat, the Template recommends the creation of a "How to Be a Cooling Center" instructions to guide cooling center activation, communications, capacity, personnel needs, and amenities provided. The guide serves as the foundational and unifying document for the program, setting direction and expectations that will serve both personnel and residents. It provides documentation and a basis for training local organizations that want to volunteer as a cooling center for their community. The volunteer cooling center program is a notable component of Chatham County NC's Heat Action Plan.[43]

In Durham County, no "How to Be a Cooling Center" guide exists in a public-facing capacity. Durham County libraries are designated as cooling centers as needed.[44] As cooling centers, libraries maintain their typical hours and the County provides an interactive map on their website for residents to find the most convenient location and their availability. To move towards expanding the existing cooling center program, detailing a guide for cooling center operations is an important first step.

In working towards expanding Durham's cooling center program, the locations of cooling centers should be carefully considered. To assess the accessibility of cooling centers to residents with high vulnerability, the locations of cooling centers and the SVI can

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[41] Alan Barreca et al., "Adapting to Climate Change: The Remarkable Decline in the US Temperature-Mortality Relationship over the Twentieth Century," *Journal of Political Economy* 124, no. 1 (February 2016): 105–59, https://doi.org/10.1086/684582.
[42] "Heat Action Plan Toolkit."
[43] "Chatham County Heat Action Plan," Plan (Chatham County: Chatham County, January 24, 2024), https://www.chathamcountync.gov/home/showpublisheddocument/66695/638484530393370000.
[44] "News | Durham County," accessed February 7, 2025, https://www.dconc.gov/Home/Components/News/News/9667/; "Cooling Stations in Durham County, NC," accessed February 7, 2025, https://webgis2.durhamnc.gov/portal/apps/webappviewer/index.html?id=b9b09b05f5ba44668f2626af7128c31d.

be compared. Many studies have examined cooling center locations and heat vulnerability. Kim et al.'s study found that spatially scattered distributions of cooling centers, rather than grouped, are more likely to be accessible, and that new cooling center sitings should account for the locations of existing cooling center facilities and spatial patterns of demographics and vulnerability.

Similarly, Fraser et al. (2018) and Watkins et al. (2024) developed methodologies for siting new cooling centers to better serve vulnerable populations.[45] Fraser et al. examined the distribution of cooling centers in Los Angeles County, CA and Maricopa County, AZ and developed a methodology for locating cooling centers such that they are better accessible to residents who are more vulnerable and in areas that have less AC and cooling amenities.[46] Fraser et al.'s method used a 15-minute walk to determine the service area of cooling centers, and assessed heat vulnerability on characteristics such as age, race, economic state, mental and physical health, AC access, homelessness, and urban heat islands. Additionally, the method considered barriers to transportation for traveling to cooling centers. Watkins et al. used the top 25% SVI as priority areas, performed a network analysis to assess their service area, and identified potential sites for new cooling facilities.

Employing methodological ideas from Fraser et al, (2018) and Watkins et al. (2024), *Figure 5* displays the SVI by census tract and a network analysis of 5-, 10-, 15-, and 20-minute walking service areas of the existing libraries that serve as cooling centers in Durham County. Most of the census tracts with the highest SVI are not accessible by a 20-minute walking service area of the cooling centers. There is ample opportunity to better serve the residents of the highest vulnerability census tracts with more accessible cooling amenities. To provide residents of high vulnerability census tracts with cooling center amenities, Watkins et al.'s method of dedicating the census tracts with the highest 25% SVI as the priority areas for cooling center program expansion can be utilized.

In addition to considering the spatial distribution of social vulnerability, the Durham 2023 Community Health Assessment (CHA) highlighted the differing dynamics of rural and urban dynamics that affect accessing cooling facilities. The Durham County Health Ministry Network, Durham Centers for Senior Life, and places of worship across the county may be important connections to engage in order to improve access to cooling amenities in

[45] Andrew M. Fraser, Mikhail V. Chester, and David Eisenman, "Strategic Locating of Refuges for Extreme Heat Events (or Heat Waves)," *Urban Climate* 25 (September 1, 2018): 109–19, https://doi.org/10.1016/j.uclim.2018.04.009; Lance Watkins et al., "A Co-Produced Workflow for Addressing Inequities in Cooling Center Access," *Community Science* 3, no. 4 (2024): e2023CSJ000038, https://doi.org/10.1029/2023CSJ000038.

[46] Fraser, Chester, and Eisenman, "Strategic Locating of Refuges for Extreme Heat Events (or Heat Waves)."

more rural areas.[47] Faith-based organizations are often trusted sites within communities and important partners in facilitating public health efforts.[48] To serve residents with high social vulnerability and/or who are located in more rural parts of the county, partnership with faith-based organizations and other community organizations may be imperative.

[47] "Durham County Health Ministry Network | Durham County - NC - Public Health," accessed February 7, 2025, https://www.dcopublichealth.org/services/health-education/health-promotion-and-wellness/durham-county-health-ministry-network; "Durham Center for Senior Life | Nonprofit Organization," accessed February 7, 2025, https://dcslnc.org/.

[48] Jeff Levin, "Faith-Based Initiatives in Health Promotion: History, Challenges, and Current Partnerships," *American Journal of Health Promotion* 28, no. 3 (January 2014): 139–41, https://doi.org/10.4278/ajhp.130403-CIT-149.

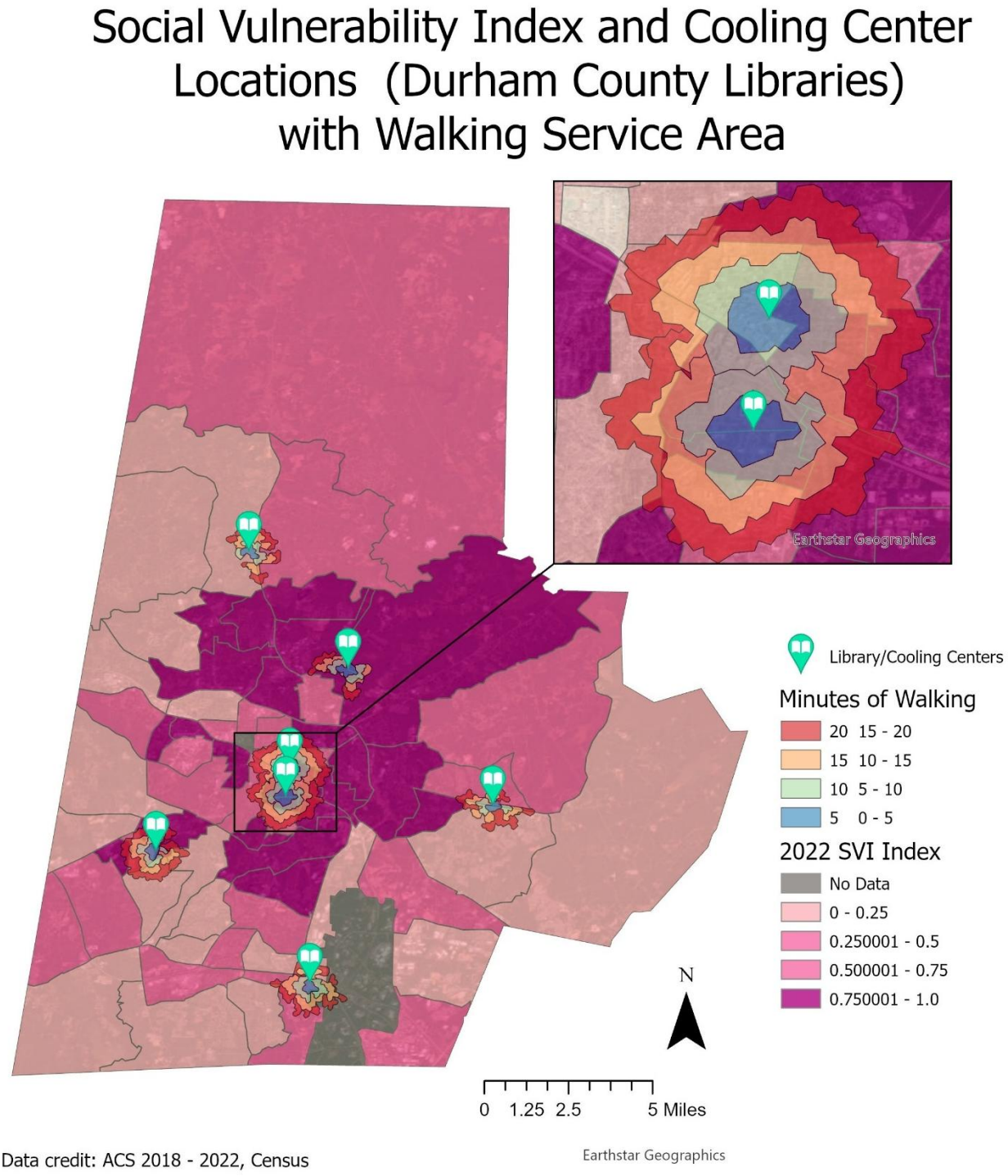

Figure 5. Map of Durham County's SVI with all libraries and their associated 5, 10, 15, and 20 minute walking service areas.

Assessing action with the FEMA framework

Risk and Impact. Spending some time in air-conditioned spaces during hot weather and extreme heat events keeps the body at more comfortable temperatures, effectively reducing users' exposure to extreme heat immediately. However, for cooling centers to be effective at reducing heat exposure and therefore risk, they must be used by residents.[49] Residents knowing of the cooling center, deciding to go, and transporting themselves to it are barriers to effectiveness of this action.[50]

Strengths, Benefits, Equity. The strengths of this action are in that it is building from an existing program, and many other municipalities across the country use this strategy and the learnings from their efforts can help inform Durham's program. The majority of census tracts with the most vulnerable residents, the top 25% SVI scores, are not currently within a 20-minute walk of an existing cooling center. Expanding the cooling center program with the priority being to establish cooling centers that serve the most vulnerable neighborhoods will build more equitable capacity and engage residents, businesses, and other organizations. Expanding the cooling center program will be an ongoing effort by the County. I estimate that from the time of plan adoption, it may only take 1-2 years to begin launching more cooling centers.

Weaknesses and Costs. While we know that AC reduces exposure to heat, there is currently no publicly available data around how many residents use the cooling centers in Durham. More information about the use of (existing and future) cooling centers is needed to describe the impacts. For example, counting the number of cooling center visitors, how long visitors stay, or a survey of visitors, would be a helpful starting point to illustrate the program's benefits.

Outside of the cost of running the air conditioning itself, the primary cost is personnel to staff the cooling centers, distribute supplies, and consistently communicate with the community. Having effective communications, logistical management, and supporting systems is vital to address the barriers and make this strategy successful at reducing heat exposure.

Continuity with other plans. Expanding cooling centers is aligned with Durham's 2023 Comprehensive Plan, particularly in its community goal that includes the objective, "…We need to retrofit our built environment and also prepare our communities, by building community capacity, to be more resilient to natural disasters and unexpected disruption.

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[49] "2024 Extreme Heat Summit -Planning and Data Analysis" (FEMA, December 2024).
[50] Stasia Widerynski et al., ""Use of Cooling Centers to Prevent Heat-Related Illness: Summary of Evidence and Strategies for Implementation.," n.d.

Low-wealth communities and communities of color in Durham will be most impacted by climate change, therefore, Durham needs to prioritize BIPOC communities in planning for a sustainable future."[51] Cooling centers are explicitly highlighted in the recommended strategies of the 2023 Durham County Community Health Assessment.[52]

Develop a hydration station program.

Action Analysis through Literature and Durham Context

Developing a hydration station program, defined as an indoor or outdoor place where people can access water fountains or bottled water, is a proposed action from NCORR's Template.

As it stands, the two notable methods in which Durham County promotes hydration stations are through water fountains in local parks and other government facilities, and operating a mobile hydration station called Durham H2O 2 Go.[53] Based on an assessment of the City of Durham Parks and Recreation facilities website accessed on February 2, 2025, 53% (51 of 98 facilities) of Durham Parks and Recreation facilities list water fountains as available amenities. Secondly, the H2O 2 Go is a mobile hydration station that has eight water fountains and eight refill stations and is available for reservations for public events in Durham County. The requirements for booking the mobile hydration station include thresholds of anticipated attendance, no one at the event can sell bottled water, operating hours can only be between 7am and 10pm, an approved inclement weather plan must be in place, an approved water connection should be present at the event space, and liability insurance must be secured. The City advertises events that the H2O 2 Go station will attend.[54] Existing hydration stations efforts in parks and through H2O 2 GO are limited to serving park-goers and attendees at events that rents the H2O 2 GO.

Outside of Durham, municipalities have implemented hydration station programs in many capacities. For example, Louisville's "Pure Tap" program presents a searchable map

[51] "Durham Comprehensive Plan," Comprehensive Plan (City of Durham and Durham County, NC, October 2023), https://www.engagedurham.com/DocumentCenter/View/599/Durham-Comprehensive-Plan_Adopted_October2023.
[52] "Durham County 2023 Community Health Assessment."
[53] "Facilities • Durham Parks & Recreation, NC • CivicEngage," accessed February 2, 2025, https://www.dprplaymore.org/Facilities?clear=True#; "Durham H2O 2 Go | Durham, NC," accessed February 2, 2025, https://www.durhamnc.gov/3937/Durham-H2O-2-Go.
[54] "City Connect: Hydration Station Events, Public Input Needed, & More!," accessed February 2, 2025, https://www.durhamnc.gov/CivicSend/ViewMessage/message/206328.

of water refill stations across businesses and other destinations in the city.[55] In a similar vein, the Los Angeles Department of Water and Power leads a Hydration Station Initiative Program that will reimburse non-residential applicants up to a specified amount for installing a publicly accessible water fountain.[56] The intent of this program is to promote access to potable water without generating single use plastic pollution. To participate, hydration stations must be accessible to the public and in areas with significant pedestrian flow, participants must maintain the fountain and allow for signage and advertising of its location.

With public access to clean and safe drinking water top of mind, several Canadian cities have piloted and installed seasonal water fountains that attach to fire hydrants that serve both people and their pets.[57] The Town of Okotoks, Canada launched two temporary water fountains connected to fire hydrants in their downtown in summer 2024, and the city of Waterloo launched one temporary water fountain in a public square the prior year. Ottawa has expanded their hydrant fountain program to include six locations across the city as of summer 2024. Each pilot program has worked with their fire departments closely to ensure that the water fountains pose no changes or challenges to emergency and fire response.

With public water fountains in Durham being located primarily in parks and DPR facilities and the H2O 2 GO station being used only at large events, there is a missed opportunity to provide continuous public access to drinking water in the heat season. Taking inspiration from Los Angeles' and the Canadian cities' initiatives, Durham County can consider working with the Water Management and Fire Departments to install season water fountains attached to the hydrants in strategic high pedestrian areas.

While the direct benefits of hydration stations can be difficult to quantify, they promote hydration which is a key component of bodily health and mitigating the effects of heat illness.

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[55] "Pure Tap Around Town," Louisville Water Company, accessed February 2, 2025, https://louisvillewater.com/partnerships/.

[56] "Hydration Station Initiative Program | Los Angeles Department of Water and Power," accessed February 2, 2025, https://www.ladwp.com/residential-services/water-quality/hydration-station-initiative-program.

[57] "Beat the Heat with New Hydrant Water Fountains in Downtown Okotoks | The Town of Okotoks," accessed February 2, 2025, https://www.okotoks.ca/your-government/newsroom/news/beat-heat-new-hydrant-water-fountains-downtown-okotoks; "City of Waterloo Launches New Fire Hydrant Drinking Station in Uptown Square | Globalnews.Ca," Global News, accessed February 2, 2025, https://globalnews.ca/news/9812973/waterloo-fire-hydrant-fountan/; Natasha O'Neill, "Water Fountains in Ottawa Get a New Look While Quenching Thirst," *CityNews Ottawa* (blog), July 29, 2024, https://ottawa.citynews.ca/2024/07/29/public-water-fountains-across-the-city-get-a-new-look/.

Anthonj et al. conducted a systematic study of literature about the water, sanitation, and hygiene (WASH) experiences of people experiencing homelessness in cities across high income countries and the impacts of extreme weather events, such as heat waves.[58] Their study identified that individuals often have limited access to drinking water fountains and other sources of water, and may rely on buying water, or refills from grocery stores, restaurants, or parks. Through surveying existing studies, Anthonj et. al found that the dehydration that unsheltered individuals experience due to limited access to water is intensified and exacerbated by extreme heat.

Assessing action with the FEMA framework

Risk and Impact. Staying hydrated helps people endure heat stress and keep their bodies cool and functioning. Like cooling centers, hydration stations rely on residents using the amenities in order to reduce heat risk. Drinking water has near-immediate effects of rehydration, reducing vulnerability to heat illness.

Strengths, Benefits, Equity. When hydration stations are used, they bolster people's bodies' ability to better manage heat stress. The placement and accessibility of hydration stations affect who benefits from them. Locating them in areas with high heat exposure, higher social vulnerability, higher population density, and significant pedestrian traffic would increase the chances of vulnerable residents benefiting from this amenity. Particularly for unsheltered individuals, having access to public water fountains may be vital to curb the effects of dehydration during extreme heat events. If this project is pursued amidst other competing priorities, I estimate this project would take 1-2 years to implement based on the development of other similar projects.

Weaknesses and Costs. Installing and maintaining seasonal public water fountains requires effort, coordination, funding, and government buy-in from departments across the local government agencies. Additionally, beyond surveying users and utilizing a flow meter to gauge the amount of water used, the breadth of impact may be hard to capture.

Continuity with other plans. This action is broadly in the spirit of the policies in the Comprehensive Plan related to access to clean drinking water and reducing the effects of heat islands on residents, however, it is not explicitly called out as a strategy in Comprehensive Plan, Community Health Assessment, or Eno-Haw Hazard Mitigation Plan.

[58] Carmen Anthonj et al., "Invisible Struggles: WASH Insecurity and Implications of Extreme Weather among Urban Homeless in High-Income Countries - A Systematic Scoping Review," *International Journal of Hygiene and Environmental Health* 255 (January 1, 2024): 114285, https://doi.org/10.1016/j.ijheh.2023.114285.

Create a workplace heat exposure standard for county personnel.

Action Analysis through Literature and Durham Context

Establishing a workplace heat exposure standard for the staff of Durham County can help to mitigate heat exposure and risk for employees and position the County as a leading organization for heat exposure policies in the Triangle. Analyzing the list of Departments in Durham County, I anticipate that an internal policy on heat exposure may be managed by Human Resources and may affect personnel in the Cooperative Extension, Emergency Management, Forest Protection, General Services, Public Health, Sheriff's Office, and the Soil and Water Conservation District.[59]

OSHA (Occupational Safety and Health Administration) at both the federal and state levels, holds the mission of establishing and enforcing workplace safety standards.[60]

All employers within the jurisdiction of OSHA are required to meet federal OSHA standards, including the General Duty Clause, which states that workplaces must be "free from recognized hazards that are causing or are likely to cause death or serious physical harm to his employees." [61] The Bureau of Labor Statistics reported 479 employees died from heat exposure and over 33,000 heat injuries or illness at work between 2011-2022.[62] There are no approved federal policies particular to extreme heat currently, however, in August 2024, federal OSHA released a Notice of Proposed Rulemaking for Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings.[63] This rule would mandate employers to establish heat plans and monitoring for both indoor and outdoor workplaces. Public comments were open through January 14, 2025, and a public hearing will take place in June 2025.

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[59] "County Departments | Durham County," accessed February 7, 2025, https://www.dconc.gov/county-departments.
[60] "About OSHA | OSHA.Gov | Occupational Safety and Health Administration," accessed January 20, 2025, https://www.osha.gov/aboutosha.
[61] "Law and Regulations | OSHA.Gov | Occupational Safety and Health Administration," accessed February 3, 2025, https://www.osha.gov/laws-regs; "Duties | OSHA.Gov | Occupational Safety and Health Administration," accessed February 3, 2025, https://www.osha.gov/laws-regs/oshact/section_5.
[62] "Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings Rulemaking | OSHA.Gov | Occupational Safety and Health Administration," accessed February 3, 2025, https://www.osha.gov/heat-exposure/rulemaking.
[63] "Heat Injury and Illness Prevention in Outdoor and Indoor Work Settings Rulemaking | OSHA.Gov | Occupational Safety and Health Administration."

Similarly at the state level in North Carolina, OSHA does not have specific standards for heat in the workplace, but it can be applicable under the General Duty Clause.[64] However, there are many resources at both the national and state levels, as well as from the National Institute for Occupational Safety and Health (NIOSH) for heat illness prevention documentation, plans, and training.[65]

The Heat Illness Prevention Program from NC OSHA outlines a program that details risk factors and steps to mitigate the effects.[66] Risk drivers can be environmental, such as temperature or humidity above a threshold or physical exertion, or personal, such as not adapted to heat or being dehydrated. The program details actions for supplying water and shade, acclimatizing employees, assessing extreme heat conditions, responding to extreme heat events and emergencies, heat training, and responding to employees who are experiencing heat illness.

Assessing action with the FEMA framework

Risk and Impact. Depending on the details of the policy implemented, the workplace heat standard for Durham County reduces heat exposure and vulnerability for personnel subject to the policy through provisions of water, shade, acclimatization, and response plans. The impact of this strategy is in reducing the severity of heat illness for Durham County personnel exposed to extreme heat through their jobs.

Strengths, Benefits, Equity. The strengths of this policy are that it addresses the impacts of the County's own occupational heat exposure, and benefits workers who experience the increased risk of heat illness associated with their jobs at Durham County. Workers with occupational heat exposure have an increased risk to heat illness than their counterparts who are less exposed to or not exposed to extreme heat in their jobs. This policy builds capacity for exposed workers to better tolerate heat. The monetary cost of implementing this action is minimal, and once the standard is developed and agreed upon, it should be relatively easy to implement. Additionally, the policy demonstrates the County's

[64] "Heat Stress | NC DOL," accessed February 3, 2025, https://www.labor.nc.gov/heat-stress#Tab-Regulations-571.
[65] "Heat Stress Prevention Program (Agriculture) | NC DOL," accessed February 3, 2025, https://www.labor.nc.gov/osh/osh-example-programs/heat-stress-prevention-program-agriculture; "Criteria for a Recommended Standard: Occupational Exposure to Heat and Hot Environments - Revised Criteria 2016.," October 31, 2024, https://doi.org/10.26616/NIOSHPUB2016106; "Heat Illness Prevention Campaign - More Resources | OSHA.Gov | Occupational Safety and Health Administration," accessed February 3, 2025, https://www.osha.gov/heat/more-resources.
[66] "Heat Illness Prevention Program | NC DOL," accessed February 3, 2025, https://www.labor.nc.gov/osh/osh-example-programs/heat-illness-prevention-program.

commitment to workplace heat regulations and is effectively within the County's ability to implement.

Weaknesses and Costs. There are a couple weaknesses associated with this policy related to political will and limited impact. While this policy is within the County's control to implement, it is unclear if there is political will or interest from management to pursue it. It is to be determined exactly which positions would be affected by this policy, however, it would be a relatively small proportion of Durham County staff, which is approximately 1900 employees.[67] Additionally, compliance and implementation of this policy may vary, resulting in less systematic impacts.

Continuity with other plans. Creating an internal heat exposure policy was not on the list of recommended strategies in the 2023 Community Health Assessment, however, a related strategy was: advocating for protecting outdoor employees from heat at the state and national level.[68]

Coordinate wellness checks and house calls to include heat illness prevention.

Action Analysis through Literature and Durham Context

There are several entities across Durham County that do wellness checks involving house visits. Wellness checks and house calls are often carried out by social service programs, public safety officials, or health care professionals. However, the trust and enduring social network that is often more prevalent in social service programs is important for the long-term impact of this action.

Durham County Social Services Department provides programs that support older, disabled, or those on Medicaid age in their homes. [69] These programs – the In-Home Aide, Home Delivered Meals Services, and In-Home Special Assistance – involve a service provider visiting an individual's home to help with personal care or meals. The Social Services website does not indicate how many people utilize these services and if there is any inclusion of heat illness prevention.

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[67] "Why Work for Durham County | Durham County," accessed April 3, 2025, https://www.dconc.gov/county-departments/departments-f-z/human-resources/careers-at-durham-county/why-work-for-durham-county.
[68] "Durham County 2023 Community Health Assessment."
[69] "In Home Aide & Home Delivered Meals | Durham County," accessed March 30, 2025, https://www.dconc.gov/county-departments/departments-f-z/social-services/aging-and-adult-services/in-home-care-home-delivered-meals.

Meals on Wheels Durham "delivers a nutritious meal, a safety check, and a smile that serves as a lifeline to seniors of limited mobility."[70] In the 2023-4 fiscal year, Meals on Wheels served 893 residents with more than 140,000 meals, 46,068 wellness calls, and 206 box fans.[71] Meals on Wheels Durham recognizes the vulnerability to heat their clientele experience. Providing further heat illness prevention resources can further bolster their existing efforts.

To strengthen heat illness prevention efforts, the National Collaborating Centre for Environmental Health's guide for doing health checks during extreme heat events can be used as a starting point.[72] The guide includes a quick risk assessment, symptoms of mild/moderate/and severe heat illness and responses, resources and items to have readily available, and how to measure indoor and body temperatures. Additionally, AARP's guide to help people stay cool in extreme heat outlines steps to take and questions to ask.[73] In 2018, New York City launched Be a Buddy, a pilot program that involved community-based organizations finding residents with high vulnerability to heat, training volunteers, and carrying out wellness checks.[74] Be a Buddy engaged more than 1300 residents and became a useful network during the first six months of the pandemic, with more than 11,000 checks occurring during this period.

Providing resources and training on heat illness prevention to organizations that are already carrying out wellness checks can help to support residents who are older, have chronic illnesses or limited mobility, or are socially isolated in extreme heat events.

Assessing action with the FEMA framework

Risk and Impact. Incorporating heat illness prevention into existing wellness checks and house calls reduces heat risk for individuals receiving this support, who are generally are more vulnerability to heat illness. Incorporating heat illness prevention can help provide support to vulnerable populations before or during a heat emergency and better equip residents with an awareness of the dangers of heat and how to mitigate its effects.

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[70] "Our Services | Meals on Wheels of Durham," accessed March 30, 2025, https://www.mowdurham.org/services.
[71] "2023-4 Meals on Wheels Durham Annual Report," Annual Report (Durham County: Meals on Wheels Durham), accessed March 30, 2025, https://www.mowdurham.org/sites/mowdurham/files/FY23-24%20Meals%20on%20Wheels%20Durham%20Annual%20Report.pdf.
[72] "Health Checks during Extreme Heat Events" (National Collaborating Centre for Environmental Health, n.d.), https://ncceh.ca/sites/default/files/NCCEH%20Extreme%20Heat%20Event%20-%20Health%20Checklist%20WEB_0.pdf.
[73] "Help Someone Stay Cool During Extreme Heat," AARP, accessed March 30, 2025, https://createthegood.aarp.org/volunteer-guides/stay-cool-extreme-heat.html.
[74] "Be a Buddy," NYC Mayor's Office of Climate and Environmental Justice, October 14, 2022, https://climate.cityofnewyork.us/initiatives/be-a-buddy/.

Strengths, Benefits, Equity. Residents are more likely to engage with someone or an organization they already know or have a relationship with, which is why leaning into the existing social network is a strength of this action. A co-benefit of this action is the further building of social networks and knowledge of extreme heat impacts and mitigation strategies. This action facilitates equitable outcomes because it is intended to bolster the resources for a population that has higher vulnerability to heat relative to the general population.

Weaknesses and Costs. The costs related to implementing this action are relatively minimal as they are primarily about providing training and resources for individuals carrying out wellness checks and house calls. In terms of weaknesses, this action as strategy for reducing heat will miss older individuals and individuals with limited mobility who are not receiving services from the existing social service programs. Additionally, the effectiveness of the strategy is based on the knowledge and understanding of the individual care provider to assess and respond to each household they check on, leaving opportunities for heat risk to be overlooked.

Continuity with other plans. The Durham County CHA aims to mitigate health effects of extreme heat by "partnering with formal and informal social service systems to educate the public about extreme heat dangers and mitigation techniques."[75]

Distribute heat relief provisions for people facing housing insecurity.

Action Analysis through Literature and Durham Context

The analysis of this heat action – providing heat relief for residents facing housing insecurity – synthesizes findings from a 2024 City of Durham assessment of homelessness, local efforts supporting homeless residents, recommendations from the NCORR template, and information from academic literature on the topic.

The City of Durham's Community Development Department conducts an annual point in time assessment of residents facing homelessness.[76] The 2024 assessment took place on January 24, 2024, and found at that time, 415 residents were experiencing homelessness, which includes people in emergency shelters, transitional units, and in unsheltered circumstances. Notably, the number of unsheltered individuals has increased

[75] "Durham County 2023 Community Health Assessment."
[76] Lloyd Schmeidler, "2024 PIT Count & HIC Report" (Durham: City of Durham, April 24, 2024), https://www.durhamnc.gov/DocumentCenter/View/56107/2024_PITHIC_Report.

from 77 in 2020 to 172 in 2024. While it is unclear how much the counts may fluctuate throughout the year, the report from the Community Development Department helps to approximate the number of individuals to potentially prepare for in providing heat relief. Additionally, the Community Development Department coordinates the Durham Continuum of Care (CoC), a network of service providers dedicated to addressing homelessness.[77]

Considering more potential collaborators for this action, the Durham Rescue Mission, Urban Ministries of Durham, and the City's HEART team all engage with Durham's housing insecure residents.[78] The Durham Rescue Mission, a local non-profit organization providing shelter and other social services, conducted 'Operation Rescue' in the summer of 2023.[79] This effort involved sending out teams to look for, support, and provide heat relief to people facing homelessness during the intense heat. Although Urban Ministries, a well-established shelter supporting more than 800 people each year, does not highlight any heat-specific initiatives on their website, they would be an important partner in this heat action due to their immense outreach and strategic location across the street from the Durham County Main Library, an important cooling center for the city. The HEART program, launched in 2022, responds to "non-violent mental health crises or quality of life concerns," and provides support accessing care and other services.[80] Collaborating with these entities may enhance the understanding of the County's circumstances, refine the heat action strategy, and implement the activities.

The NCORR Toolkit directly identifies "Provide Heat Relief for People Experiencing Housing Insecurity" and the associated action in the Draft Plan was adapted from the Toolkit recommendations.[81] The Toolkit suggests identifying a leading department, community collaborators, and recommended items to provide to people experiencing housing insecurity. The provisions are categorized into hydration, sun protection, cooling relief, and communications/information.

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[77] "Durham, NC Continuum of Care (CoC) | Durham, NC," accessed March 23, 2025, https://www.durhamnc.gov/4934/Durham-NC-Continuum-of-Care-CoC.
[78] "About | Durham Rescue Mission | Raleigh-Durham-Chapel Hill Homeless Shelter," July 3, 2013, https://durhamrescuemission.org/about/; "Urban Ministries of Durham," Urban Ministries of Durham, accessed March 23, 2025, https://umdurham.org/; "Community Safety | Durham, NC," accessed March 23, 2025, https://www.durhamnc.gov/4576/Community-Safety.
[79] "'Anyone Can Come': Scorching Temperatures Force Durham Rescue Mission to Become Cooling Shelter," ABC11 Raleigh-Durham, July 26, 2023, https://abc11.com/homeless-in-heat-extreme-wave-dangers-durham-rescue-mission/13553079/; "About | Durham Rescue Mission | Raleigh-Durham-Chapel Hill Homeless Shelter."
[80] "Community Safety | Durham, NC."
[81] "Heat Action Plan Toolkit."

While many academic studies agree on the heightened vulnerability of individuals experiencing homelessness, a study published in 2024 was among the first to quantify the disparity in heat mortality.[82] Lin et al.'s study estimated that unsheltered people in Las Vegas and Los Angeles experience heat mortality rates that are 10 to 100 fold higher than the public.[83] While these estimates were specifically for the two west coast cities, the heightened vulnerability and exposure to extreme that unsheltered individuals experience should not be underestimated.

As more research emerges at the intersection of extreme heat and homelessness, the gap in evidence investigating the effectiveness of interventions is becoming more apparent.[84] There is a lack of evaluations for initiatives around caring for unsheltered people during extreme heat events. This manifests as somewhat of a weakness of this action since the primary guidance for caring for unsheltered individuals is generally to provide the known hydration and cooling strategies amidst the barriers of their circumstances. As both homelessness and the frequency of extreme heat events increase, I anticipate that municipalities and non-profits will ramp up their efforts to protect their unhoused residents and more program evaluations will emerge to help refine such efforts.

Assessing action with the FEMA framework

Risk and Impact. This action aims to reduce immediate heat risk by providing temporary heat relief to unsheltered individuals, who are among the most vulnerable to extreme heat impacts. Considering the exponentially higher heat mortality rates unsheltered individuals experience, the impact of the provisions can be lifesaving.

Strengths, Benefits, Equity. This action facilitates equitable outcomes by providing heat relief to one of the county's most vulnerable groups. In addition to its strength in equity, this action is relatively easy and low-cost to implement.

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[82] "Extreme Heat May Substantially Raise Mortality Risk for People Experiencing Homelessness," accessed March 23, 2025, https://www.bu.edu/sph/news/articles/2024/extreme-heat-may-substantially-raise-mortality-risk-for-people-experiencing-homelessness/; Holly Samuelson et al., "Housing as a Critical Determinant of Heat Vulnerability and Health," *Science of The Total Environment* 720 (June 10, 2020): 137296, https://doi.org/10.1016/j.scitotenv.2020.137296; C. J. Gabbe et al., "Reducing Heat Risk for People Experiencing Unsheltered Homelessness," *International Journal of Disaster Risk Reduction* 96 (October 1, 2023): 103904, https://doi.org/10.1016/j.ijdrr.2023.103904; Zihan Lin et al., "Daily Heat and Mortality among People Experiencing Homelessness in 2 Urban US Counties, 2015-2022," *American Journal of Epidemiology* 193, no. 11 (November 4, 2024): 1576–82, https://doi.org/10.1093/aje/kwae084.

[83] Lin et al., "Daily Heat and Mortality among People Experiencing Homelessness in 2 Urban US Counties, 2015-2022."

[84] J. Leggat et al., "Heatwaves and Homelessness," *Perspectives in Public Health* 144, no. 2 (March 5, 2024), https://doi.org/10.1177/17579139231224690.

Weaknesses and Costs. A weakness of this action is that it is reactionary and would need to occur urgently when there is an extreme heat event, and repeatedly for the multiple heat events occurring throughout the season. Another weakness of this strategy is that the party responsible for this action must physically find the unsheltered individuals, and any individuals they do not engage with will not receive the benefits.

Continuity with other plans. This action is not explicitly highlighted in other plans; however, it aligns broadly with the CHA's intentions of having appropriate responses when heat is in the forecast.

Partner with youth sports to encourage heat safety.

Action Analysis through Literature and Durham Context

There are many organizations that operate youth sports through leagues, camps, and other activities in Durham, including the City of Durham's Parks and Recreation (DPR) Department, the YMCA of the Triangle, and i9 Sports. Collaborating with DPR to encourage heat safety will be the focus of this action because it is the most feasible given the many collaborations between the two local governments.

As of late March 2025, there were 40 youth and teen athletic activities posted to DPR's reservation site.[85] DPR has no publicly accessible policies in place for extreme heat and youth sports. The only mention of extreme heat on their website is related specifically to the High Ropes Discovery Course, stating "Extreme heat (95 degrees+), cold, wind and dangerous storm conditions which endanger the safety of the participant may result in the postponement or cancellation of the program." [86]

Youth are more vulnerable to heat because their bodies are less efficient than adults at managing heat and take more time to acclimatize to hotter temperatures.[87] Youth may not be aware of their hydration or thermal comfort, often depending on adults or caretakers to manage it for them. Through sports, school, and other activities, children and teens have more exposure to heat, and when playing sports, their exertion exacerbates their

[85] "Activity Search | Online Services," accessed March 29, 2025, https://anc.apm.activecommunities.com/dprplaymore/activity/search?onlineSiteId=0&locale=en-US&activity_select_param=2&activity_category_ids=26&activity_other_category_ids=11&activity_other_category_ids=12&viewMode=list.
[86] "FAQs • Durham Parks & Recreation, NC • CivicEngage," accessed March 29, 2025, https://dprplaymore.org/FAQ.aspx.
[87] OA US EPA, "Heat and Teenage Athletes," Collections and Lists, June 25, 2024, https://www.epa.gov/children/heat-and-teenage-athletes.

vulnerability to heat illness.[88] The US Global Change Program estimates that 9,000 high school athletes across the US receive medical treatment for heat illness each year. Nationally, youth heat illness and mortality are increasing. For these reasons, it is important that coaches, staff, camp counselors, and other caregivers consider and facilitate heat safety among the youth activities they lead.

Heat-related policies from the National Federation of State High School Association, the organization that oversees high school sports, serve as a useful case study to help determine which components of heat safety related to youth sports are most relevant. Their course on heat illness prevention concentrates on acclimatization, guidance for modifying or restricting sports, hydration plans, and creating emergency action plans.[89] The Nicholas Institute for Energy, Environment & Sustainability's Heat Policy Innovation Hub released a set of policy recommendations for managing heat stress in student athletes that centers on heat monitoring and guidance for coaches for how to modify sports programs based on environmental factors.[90] Outside of school sports, several YMCAs across the country have publicly available heat policies and guidelines.[91] They detail the heat index threshold at which games are cancelled, who makes cancelation decisions – how and when, advice for staying cool in increasing levels of heat, and information on acclimatization and dehydration.

To encourage heat safety in youth sports, Durham County should collaborate with DPR to better understand the current approach to heat safety. Based on the current approach, Durham County can encourage heat safety by providing training and awareness of acclimatization, environmental heat monitoring, hydration/break scheduling, and emergency action plans.

Assessing action with the FEMA framework

Risk and Impact. Children and teens are particularly vulnerable to heat illness while participating in sports. This action serves as a starting point for advocating for heat safety in youth sports to reduce and better respond to heat illnesses in these circumstances.

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[88] J. L. Gamble et al., "Ch. 9: Populations of Concern," *The Impacts of Climate Change on Human Health in the United States: A Scientific Assessment* (U.S. Global Change Research Program, Washington, DC, April 4, 2016), https://health2016.globalchange.gov/node/16/index.html.
[89] "Heat Illness Prevention," accessed March 29, 2025, https://nfhslearn.com/courses/63975.
[90] Jordan Clark, "A Game Plan for Heat Stress: Policy Recommendations for High School Sports," Text (Nicholas Institute for Energy, Environment & Sustainability, Duke University, July 17, 2023), https://nicholasinstitute.duke.edu/publications/a-game-plan-for-heat-stress.
[91] "Summer Heat Policy - YMCA of the Greater Tri-Cities," https://ymcatricities.org/, accessed March 29, 2025, https://ymcatricities.org/summer-heat-policy/.

Providing training on heat illness prevention and potentially modifying the sports schedules can help to reduce exposure to the extreme heat and avoid heat illness and death.

Strengths, Benefits, Equity. This action is strengthened by the immense research and guidance that exists for youth sports and heat. Assuming that sports can be rescheduled, participants can seek refuge from the heat through shade and water breaks, and the coaches and other responsible adults monitor the youth athletes, heat illness can be avoided. This action promotes equitable outcomes for youth athletes who experience increased exposure and vulnerability to extreme heat.

Weaknesses and Costs. The costs related to implementing this action are relatively minimal as they are primarily about providing training and resources. Like the wellness checks, youth athletes who are not participating in sports leagues that encourage heat safety will not receive the benefits of it. The effectiveness of this strategy is rooted in the actions and awareness of the coaches and other staff, creating opportunities for fragmented implementation.

Continuity with other plans. This action is not explicitly highlighted in other plans; it aligns broadly with the CHA's intention to have appropriate responses when heat is in the forecast.

Expand equitable access to green space.

Action Analysis through Literature and Durham Context

How Durham County has developed over the years has resulted in inequitable access to green space – parks, tree canopy, and open space. There are many efforts across the County working to improve access to parks, tree canopy, and open space equitably.

The City of Durham's Parks and Recreation's 2013 master plan found that residents' concerns included "access to parks and programs is not consistent across Durham. Some areas (such as northern Durham and Parkwood) voiced concern about the lack of parks in their neighborhoods, while other areas with an adequate supply of parks are choosing not to use some of them." [92] One of the guiding principles of the 2013 plan was 'Optimizing Current Facilities and Programs,' which included "working toward an equitable distribution of recreation resources and opportunities." [93] The 2013 plan does not explicitly mention heat-related benefits of parks, but outlines other environmental, economic, and social

[92] "City of Durham Parks and Recreation Master Plan 2013," Master Plan (Durham: Durham Parks and Recreation, August 19, 2013), https://www.dprplaymore.org/DocumentCenter/View/75/Durham-Parks-and-Recreation-Master-Plan-2013-PDF.
[93] "City of Durham Parks and Recreation Master Plan 2013."

benefits. DPR is currently in the process of developing its new Comprehensive Parks, Recreation and Open Space System Plan, which is set to be adopted in summer 2025 and will aim to continue efforts around social equity.

The City's urban forestry program, operated out of the General Services Department, oversees tree management on City-owned and right-of-way property.[94] The 2018 Urban Forestry Management Plan found that 52% of the city has tree canopy coverage, determined high priority areas of the city based on existing canopy and residents' vulnerability, and set a goal to plant 85% of the new trees in high priority areas.[95] Heat intensity was a consideration in identifying high priority areas. Figure 7 displays the findings from the tree canopy study and surface temperature, demonstrating how increased tree canopy results in generally lower relative surface temperatures.

Keep Durham Beautiful, a local non-profit focused on environmental initiatives, gave away 277 trees and planted an additional 352 trees in places across the city with less tree canopy.[96] In 2023, the City of Durham and Keep Durham Beautiful were awarded $5.3 million from USDA for 4,000 trees to be planted in disadvantaged neighborhoods.

Durham County's Engineering and Environmental Services Department includes an Open Space Program that aims to preserve open space throughout the county, with a particular focus on agricultural and watershed properties.[97] More than 4,000 acres have been preserved, and several small area open space plans have been developed over the last 35 years. The most recent open space plan, the Urban Open Space Plan completed in 2017, incorporates considerations of the cooling effects of open space and tree canopies.

The urban forestry program approached tree canopy access across the city by determining high priority areas based on tree canopy coverage, socio-economic factors, enhanced walkability, and distributing benefits to vulnerable or marginalized residents.[98] Keep Durham Beautiful works to increase the canopy in areas that need it most, although they do not indicate exactly how they determine which areas these are. While the $5.3 million grant that Keep Durham Beautiful and the City received for tree planting in disadvantaged areas is a move in the direction of equitable access to green space, it is unclear and undecided how equitable access to greenspace is measured. DPR and the

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[94] "Urban Forestry | Durham, NC," accessed March 30, 2025, https://www.durhamnc.gov/799/Urban-Forestry.
[95] "Urban Forest Management Plan."
[96] "Keep Durham Beautiful," Keep Durham Beautiful, accessed March 30, 2025, https://www.keepdurhambeautiful.org.
[97] "About the Open Space Program | Durham County," accessed April 4, 2025, https://www.dconc.gov/county-departments/departments-a-e/engineering-and-environmental-services/open-space-and-real-estate-division/about-the-open-space-program.
[98] "Urban Forestry | Durham, NC."

Open Space Program touch on the topics of heat and/or equity in their documents but do not demonstrate exactly what they mean or more specific actions they will undertake to address them. Each of these entities may very well be understanding and approaching equity at least slightly if not considerably differently from one another, making it difficult to understand the status of this action.

Of the entities analyzed, the urban forestry program offers the most detailed and transparent process to measure and take action on equitable access to green space. Using their approach as a starting point, DPR, Keep Durham Beautiful, the urban forestry program, and Open Space Program should collaborate on streamlining an approach that is detailed yet flexible enough to measure how each of their entities' initiatives are expanding equitable access to green space. This way, they frame the challenge of equitable access to green space the same way and all their efforts can be aggregated to understand what is happening collectively. If all the entities are using the same or very similar method, there will be a more cohesive and systematic perspective on the action and its status.

Phoenix's Cool Corridors Program facilitates tree planting, focusing on areas where more trees would be most impactful and keep pedestrians and cyclists cooler.[99] They aim to "plant the right tree in the right place" – to make sure that the tree choice is appropriate for the location and all of the intended benefits will come to fruition.

[99] "Cool Corridors Program," accessed April 4, 2025, https://www.phoenix.gov/administration/departments/streets/initiatives/cool-corridors.html.

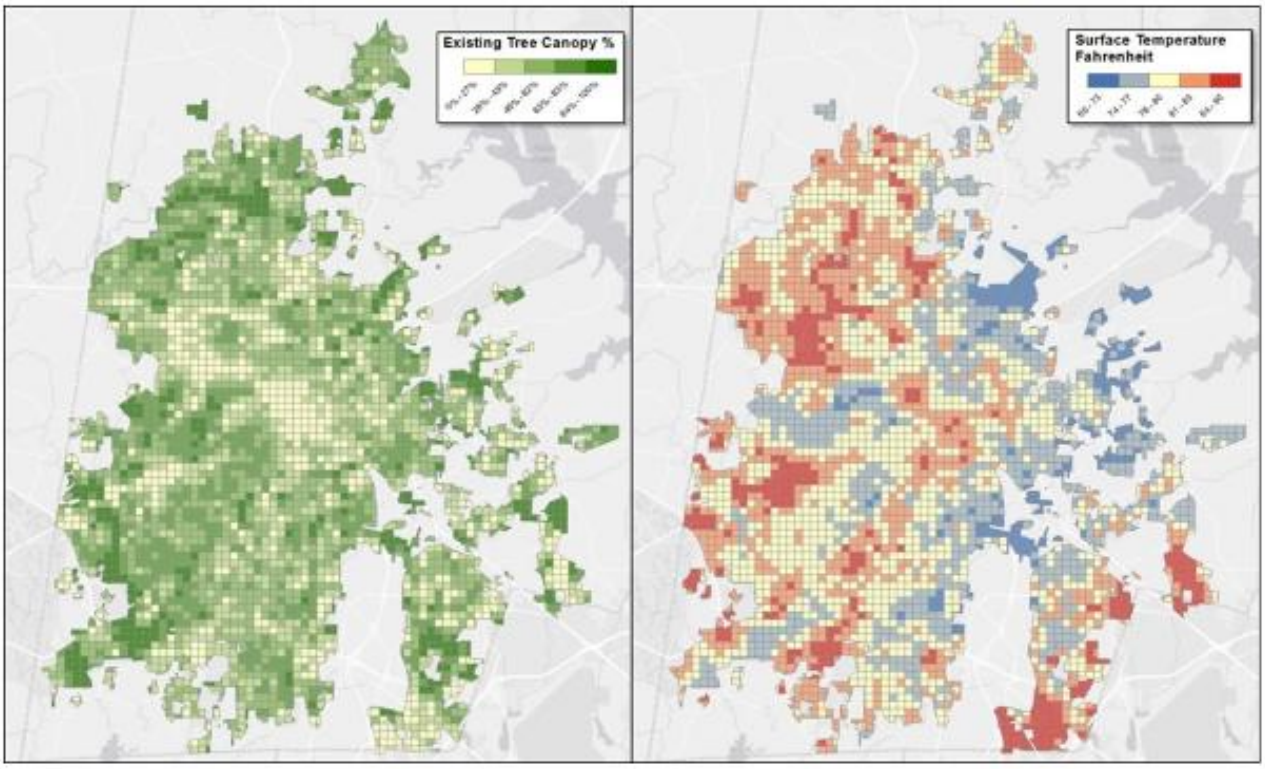

Figure 6. Tree canopy coverage and surface temperature across the city of Durham, from the Urban Forest Management Plan (2019).[100]

There is a significant amount of literature on the economic, social, ecological, and aesthetic benefits of green space – trees in particular. McDonald et. al studied 97 cities across the US and found that tree coverage decreased temperature in urban areas, reduced energy costs, helps to prevent heat-related death.[101] They estimated that the heat-related economic value of trees based on avoided death, injury, and energy cost is between $21-$49 per person per year. Chen et. Al offers a methodology to understand the spatial relationship of equitable green space using the Gini coefficient, a measure of inequality, and predictive modeling.[102]

[100] "Urban Forest Management Plan."
[101] Robert I. McDonald et al., "The Value of US Urban Tree Cover for Reducing Heat-Related Health Impacts and Electricity Consumption," *Ecosystems* 23, no. 1 (January 1, 2020): 137–50, https://doi.org/10.1007/s10021-019-00395-5.
[102] Jie Chen et al., "Which Green Is More Equitable? A Study of Urban Green Space Equity Based on Morphological Spatial Patterns," *Urban Forestry & Urban Greening* 91 (January 1, 2024): 128178, https://doi.org/10.1016/j.ufug.2023.128178.

Assessing action with the FEMA framework

Risk and Impact. Equitable access to green space reduces heat risk for residents by reducing the air temperature and providing shade.

Strengths, Benefits, Equity. In addition to reducing the heat risk, green space provides significant ecological, economic, social, and aesthetic co-benefits. This action is strengthened by its equity focus as the entities carrying out this work will frame the challenge of equitable access to green space in the same or very similar way. There will be a transparent and clear methodology used to measure inequitable access to green space the work being done to address it.

Weaknesses and Costs. Trees take decades to grow to a size that provides shade and require substantial maintenance over their lifespan. The maintenance and equipment, personnel, right to the land (public right of way, government owned, or some other option), and other related costs make this action relatively expensive and time consuming.

Continuity with other plans. Expanding equitable access to green space is highlighted direct in the objectives of both the Comprehensive Plan and the Durham CHA.

Pass a cooling ordinance.

Action Analysis through Literature and Durham Context

Cooling ordinances set a requirement for dwelling units to have cooling capabilities to a certain temperature. Durham's Code of Ordinance, Section 10-234e requires the ability to heat all dwelling units to 68°F, with a variance up to 10°F.[103] Cooling ordinances can be conceptualized as the cooling equivalent of heating provisions of Section 10-234e.

Cities such as Phoenix and Chicago, as well as Montgomery County, Maryland, enacted cooling ordinances.[104] Phoenix mandates that landlords must provide cooling that is functional and can cool rooms to 82°F or lower for AC units and 86°F if cooled by evaporative cooling.[105] When the heat index is above 80°F, Chicago's 2022 Cooling Ordinance requires air conditioning in the communal areas of some residential buildings, including high rises, buildings with over 100 units, and housing for older adults.[106] These communal cooling areas serve as localized cooling centers for residents. Montgomery County, Maryland's cooling ordinance necessitates that landlords must provide functional air conditioning that can cool the dwelling unit to 80°F between June 1st and September 30th in townhouses and multi-family rentals.[107]

The activities of passing a cooling ordinance in the Draft Durham Heat Action Plan are modeled after the steps and considerations taken by Los Angeles County. In efforts to protect the most heat vulnerable residents, the Los Angeles County Board of Supervisors tasked county personnel with developing a cooling ordinance that mandates a maximum indoor temperature for rentals in January 2024.[108] The first major step is to determine a maximum indoor threshold. Other considerations such as the cost of upgrades,

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[103] Durham County Code of Ordinances § 10-234(e).
"ARTICLE VI. - HOUSING CODE | Code of Ordinances | Durham, NC | Municode Library." Accessed April 20, 2025.
https://library.municode.com/nc/durham/codes/code_of_ordinances?nodeId=PTIICOOR_CH10BUBURE_ARTVIHOCO.

[104] "Legal Approaches to Alleviating the Effects of Extreme Heat Disparities in Cities," accessed March 20, 2025, https://www.law.upenn.edu/live/news/14753-legal-approaches-to-alleviating-the-effects-of.

[105] "Chapter 39 Art. II Maintenance Standards," Phoenix City Code, accessed March 19, 2025, https://phoenix.municipal.codes/CC/39_ArtII.

[106] "2022 Cooling Ordinance," accessed March 19, 2025, https://www.chicago.gov/content/city/en/depts/bldgs/supp_info/cooling-requirements.html.

[107] "Air Conditioning Requirements in Rental Townhome or Multi-Family Dwelling Unit," Montgomery County, April 9, 2020, https://mcgmd.wufoo.com/forms/z1y011yn0ke6xfz/.

[108] Hilda Solis and Lindsey Horvath, "Establishing a Safe Maximum Temperature Threshold for Residential Units," Revised Motion, January 23, 2024, https://file.lacounty.gov/SDSInter/bos/supdocs/188021.pdf.

establishing a phased approach for implementation, and anti-displacement policies to protect tenants from bearing the brunt of the cost.[109]

While the exact stipulations of cooling ordinances vary from municipality to municipality, passing a cooling ordinance as an extreme heat related action prioritizes residents', and often specifically renters', rights to cooling amenities in their homes and sets thresholds of habitability. Since 1960, 80% of heat related deaths have been avoided due to air conditioning.[110]

As it relates to AC access at home, physically having a functional unit is not the only barrier. The cost of running the unit at a comfortable level may be unaffordable for residents. In the development of a community-based heat plan, the City of Philadelphia surveyed community members of a neighborhood with high heat vulnerability and found that although 88% of respondents had AC, 77% said it was too hot in their houses.[111] Despite high indoor temperatures, survey respondents often stay at home during extreme heat. While most respondents view access to AC and fans will help residents keep cool, a quarter of respondents report that assistance paying utility bills would help to beat the heat. High utility costs are one component of a household's energy burden, the proportion of household income spent on home energy expenditures and particularly affect low-income residents.[112] Approximately 6% of household income dedicated to energy costs is considered affordable, and it is estimated that over 900,000 households in North and South Carolina have an average energy burden of 16% of household income, significantly over the affordability level.[113] The high and rising cost of air conditioning should not be overlooked as a barrier to accessing life-saving air conditioning.

Passing a cooling ordinance can help to fill the gaps in AC access and demonstrate the importance of cooling infrastructure in Durham County. However, a cooling ordinance alone does not help residents pay for the high and potentially unaffordable costs of running the AC at comfortable levels or improve home weatherization and efficiency to maximize cooling.

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[109] Rebecca Ellis and Hayley Smith, "L.A. County Looks to Require Rental Units to Stay Cool in Summer," Los Angeles Times, January 23, 2024, https://www.latimes.com/california/story/2024-01-23/los-angeles-county-looks-to-require-units-stay-cool-during-summer.
[110] Barreca et al., "Adapting to Climate Change."
[111] "Beat the Heat Hunting Park," A Community Heat Relief Plan (Philadelphia), accessed March 19, 2025, https://www.phila.gov/media/20190719092954/HP_R8print-1.pdf.
[112] "Low-Income Household Energy Burden Varies Among States — Efficiency Can Help In All of Them" (US Department of Energy, 2018), https://www.energy.gov/sites/prod/files/2019/01/f58/WIP-Energy-Burden_final.pdf.
[113] "Energy Poverty," Convergence of Climate-Health-Vulnerabilities, accessed March 19, 2025, https://convergence.unc.edu/vulnerabilities/energy-poverty/.

Assessing action with the FEMA framework

Risk and Impact. Implementing a cooling ordinance reduces the indoor heat exposure residents experience at home, particularly for renters.

Strengths, Benefits, Equity. The benefits of a cooling ordinance are to ensure AC is functional and have regulation related to habitability for heat.

Weaknesses and Costs. A cooling ordinance does not modify the energy burden of running AC at home. Passing a cooling ordinance may take a substantial amount of time to phase in and requires enforcement.

Continuity with other plans. Passing a cooling ordinance is highlighted directly in the policies of the Comprehensive Plan and the recommended strategies of the Durham CHA.

Discussion

Synthesizing these actions together into a plan demonstrates a concerted effort to address the many impacts of extreme heat for Durham County residents. The plan has strengths in that it recognizes the unequal exposure and vulnerability to heat across the county. To this end, several actions are tailored to address particular populations who experience the heightened vulnerability or exposure to extreme heat.

The actions engage with the impacts of extreme heat in many ways. Cooling centers and hydration stations require residents to use the amenities to reduce heat risk, and in so doing, reduce users' vulnerability to heat illness in the immediate moment. Implementing heat illness prevention through wellness checks, encouraging heat safety in youth sports, and providing heat relief to unsheltered individuals provides necessary resources to address the increased vulnerability to heat that certain populations experience when extreme heat is in the forecast. Enacting a workplace heat exposure standard for Durham County personnel demonstrates commitment to workplace heat safety and helps to create a platform from which the county can further advocate for occupational heat safety. Working towards a cooling ordinance and expanding equitable access to greenspace will facilitate cooler environments both indoors and outdoors for residents in the long term.

While all the actions promote an awareness of the impacts of heat, they also require some amount of communication – to the public, to individuals, between stakeholders – in order to be effective. The benefits of the actions will vary based on how the responsible parties implement their actions. As these actions generate awareness, the ultimate goal would be for the culture of Durham County residents to begin to shift towards an attitude that responds to the risks of extreme heat, with a knowledge of the amenities and resources available to them to mitigate the impacts.

The following table summarizes the key impacts, strengths, and weaknesses of the collection of heat actions developed and evaluated in this project.

Action	Impacts	Strengths	Weaknesses
Expand cooling center program.	Reduces heat exposure for users and builds capacity for vulnerable residents	Common heat mitigation strategy; relatively low cost and quick timeline for implementation; prioritizes expanding program in neighborhoods with high vulnerability	Only effective if residents use it; more data on cooling center usage is needed
Develop a hydration station program.	Reduces heat vulnerability for users	Bolster capacity for heat stress for users, especially where access to drinking water in public is limited and heat vulnerability and exposure is high	Requires installation, maintenance, and government buy-in and coordination; may require a stakeholder to champion this strategy to make it a priority; hard to quantify water fountain usage with heat risk reduction
Develop a workplace heat exposure standard for county personnel.	Reduces heat exposure and/or vulnerability for county personnel	Addresses county's occupational heat exposure and demonstrates commitment to workplace heat regulations	Limited by political will and impacts a relatively small proportion of Durham County personnel
Incorporate heat illness prevention into wellness checks and house calls.	Reduces heat risk by providing support to individuals who are older and/or have limited mobility	Builds from existing social networks and provides resources specifically to a population that has high vulnerability to heat	Individuals who do not receive the social services will not benefit from this action; this strategy relies on the knowledge and awareness of each individual care provider to implement properly
Promote heat safety in youth sports.	Reduces heat exposure and/or vulnerability for young athletes who are particularly vulnerable to heat impacts	Substantial amount of research on this topic exists;	Young athletes not participating in leagues that promote heat safety will not benefit; implementation fully depends on the responsible party (coaches, staff)
Distribute heat relief provisions for individuals experiencing housing insecurity.	Provides temporary, immediate relief to the most vulnerable residents during extreme heat events.	Avoided heat illness and death can be substantial, and implementation is relatively easy and low cost	Responsible party must physically find the unsheltered individuals urgently; action does not affect improve longer term vulnerability and exposure
Expand equitable access to green space.	Reduce heat exposure by reducing air temperature and providing shade	Avoided heat illness, death, energy costs. Ecological, economic, social, aesthetic co-benefits	Green space is costly and time consuming to acquire and maintain; trees take a long time to grow and increase the canopy
Pass a cooling ordinance.	Reduce heat exposure by ensuring functional air conditioning at home	Establishing regulation for habitability related to heat to protect renters	Will take time to phase in; does not improve the cost burden of operating a functional AC

Next Steps and Conclusion

This project developed and evaluated a collection of eight potential heat actions for Durham County, North Carolina. These actions are a subset of a larger list of heat actions in consideration by the county. To bolster this heat action plan, other actions such as developing a comprehensive heat communication strategy, incorporating extreme heat related resources in local resilience hubs, and assist low-income residents with home weatherization at multiple price points.

For next steps on this project, I recommend:

- Continuing to develop this set of actions and others based on the County's feasibility, capacity, and buy-in
- Engaging local heat-related stakeholders and residents for feedback on the proposed actions
- Prioritize measuring project outcomes to quantify benefits
- Build into the plan a strategy to evaluate and refine interventions
- Developing a pathway to adoption and implementation