Cornell Initiative on Aging and Adaptation to Extreme Heat

2024 Annual Report

JACOBS TECHNION-CORNELL INSTITUTE AT CORNELL TECH

Weill Cornell Medicine

Public Health
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Contents

Acknowledgments

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Initiative Overview

The Cornell Initiative on Aging and Climate Adaptation is an applied research collaboration focused on improving, understanding, and developing novel solutions to the challenges of older populations in climate-stressed urban areas, including heat stress, flooding, and air pollution due to wildfires.

The Growing Health Risks of Extreme Heat for Older Adults in Cities

The U.S. population is aging rapidly and increasingly vulnerable to the health hazards of extreme weather caused by climate change. By 2030, the U.S. Census Bureau projects that more than 21 percent of the U.S. population will be over 65, and older adults will outnumber children for the first time in U.S. history.

At the same time, climate change is producing more frequent and intense heat waves, air quality emergencies, and other extreme weather events. Older adults are more vulnerable and less resilient to these combined stresses, due to underlying health issues and limited economic resources—as a result, 82 to 92 percent of annual heat mortality occurs in individuals over age 60.[1]

Climate stresses are magnified in urban areas. And the health burden is growing. In cities, climate stresses can be exacerbated by the urban heat island effect and proximity to flood zones. As a result, those aged 65 and over account for more heat-related hospitalizations than any other group.

The costs of these hospitalizations are substantial. One study estimated the human mortality and morbidity costs associated with 10 climate-sensitive case study events in a single year (2012) at more than $10 billion. These costs are rising as severe weather events become more frequent and intense, adding to the already growing burden of a rapidly aging population.

Mission, Vision, and Core Values

Our mission is to protect vulnerable older adults from the effects of extreme heat events through interdisciplinary applied research on risks and technology-enabled interventions. We envision a future where all older adults can safely adapt to and thrive during extreme heat events, supported by equitable and effective interventions coordinated across sectors, sites, and systems.

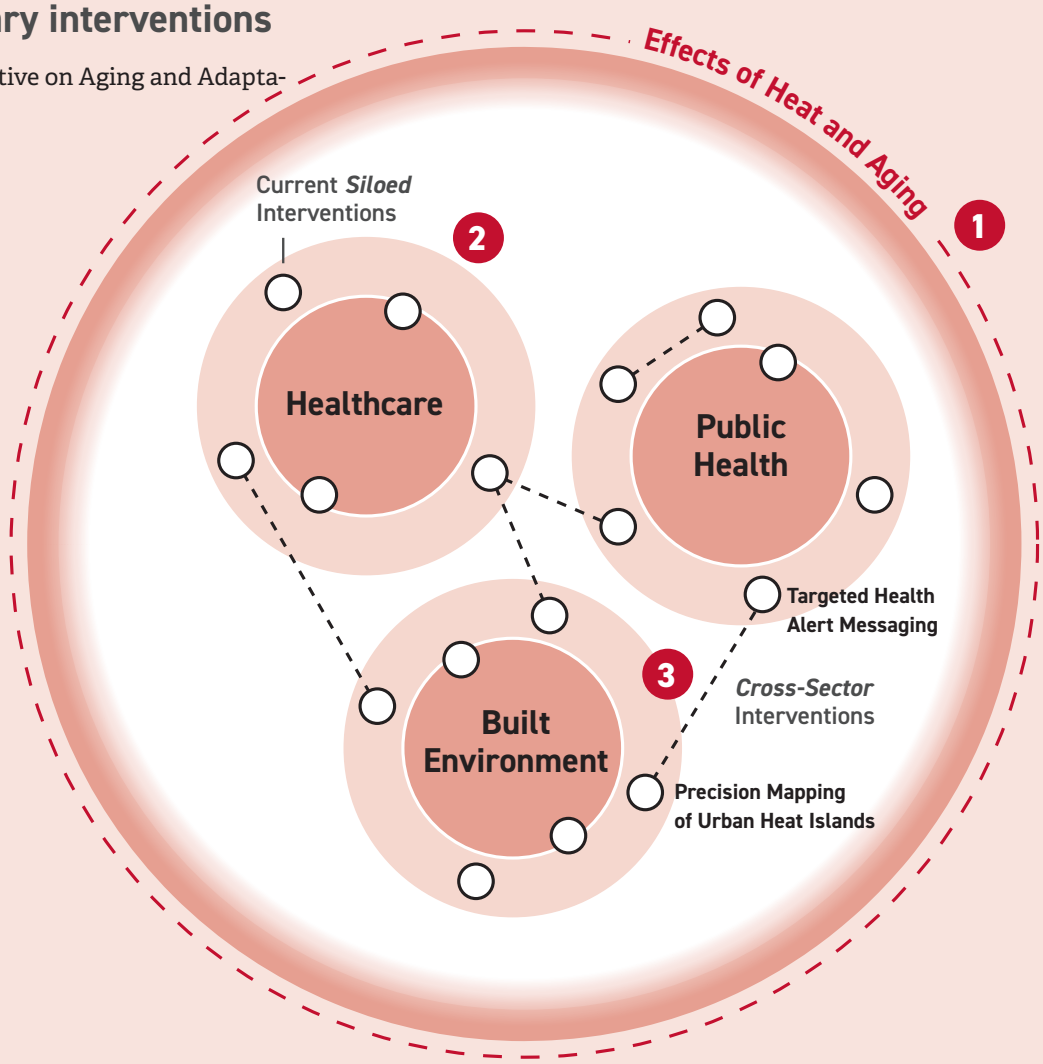
Through our work, we emphasize the importance of the following key values:

1 Kenny GP, Yardley J, Brown C, Sigal RJ, Jay O. Heat stress in older individuals and patients with common chronic diseases. CMAJ. 2010 Jul 13;182(10):1053-60. doi: 10.1503/cmaj.081050. Epub 2009 Aug 24. PMID: 19703915; PMCID: PMC2900329.

Figure 1.

Advancing adaptation to heat for older adults through interdisciplinary interventions

Source: Cornell Initiative on Aging and Adaptation to Extreme Heat



1 Climate Stress and Aging

More frequent, intense, and longer heat waves are disproportionately impacting aging populations.

2 Institutional Responses

Three major systems support the well-being of older adults under climate stress. But they operate independently.

3 Opportunities for Cross-Sector Intervention

Digital technology provides an opportunity to cut across institutional boundaries—innovating through data exchange, service integration, and optimization.

- Evidence-based: We ground solutions in rigorous research and evaluation.
- Equity: We prioritize vulnerable populations and address systemic disparities.
- Innovation: We leverage digital tools and novel data sources to develop effective and scalable solutions.
- Integration: We bridge silos between clinical medicine, public health, and urban systems engineering.
- Collaboration: We initiate and nurture partnerships across sectors and institutions.

Research for Impact

The initiative draws on expertise in medicine, public health, digital health, operations research, and urban systems. It conducts research and develops evidence-based interventions that integrate digital technologies, policy tools, and built environment designs. We pursue impact through our work in three ways.

Mobilizing New Data Streams

There are many new and underutilized sources that can improve how we measure health risks and health impacts of climate stress. For instance, healthcare claims records can help identify vulnerable groups who seek care during climate stresses, and the types of treatments they receive. Data collected by mobile and wearable devices can provide frequent, large-scale, longitudinal data on the health impacts of climate stress. And large-scale, anonymized human mobility data collected via cell phones and instrumented vehicles can reveal how older adults move throughout the city and the health resources they use.

Informing New Models

These new data allow us to answer under-explored questions. What unseen health impacts from climate stress are visible in digital health records? What factors influence people's decisions about how, where, and when to seek care during periods of climate stress? What alternatives do people utilize for receiving or providing care when facilities and transportation are unavailable due to severe weather? In tandem with conventional sources of public health data, new data can be used to develop policy modeling and analysis tools about the conditions that create climate stress risk for older adults.

Designing New Interventions

These data and models can inform the design and implementation of interventions that combine medical, digital, policy, and built environment assets to target the most vulnerable segments of the older-aged population. For example, knowing about the types of care and how people obtain it can highlight use cases for extending the capabilities of virtual care for older adults in climate-impaired settings, and policies and infrastructure that are required to incentivize or enable these solutions.

Initiative Partners

The Initiative employs a trans-disciplinary and translational approach—it involves multiple disciplines to develop new concepts, theories, and methods, and it puts basic research to use in real-world settings that benefit people.

Jacobs Institute at Cornell Tech

The Jacobs Institute fosters radical experimentation at the intersection of research, education, and entrepreneurship. Established jointly by Cornell University and the Technion-Israel Institute of Technology, our mission is to transform key industries through technological innovation, deep-tech startups, and uniquely skilled talent.

Within the Jacobs Institute, the Health Tech Hub engages in cutting-edge research, entrepreneurship, and education at the intersection of health and technology. We identify healthcare challenges and opportunities, apply research in real-world settings, and jump-start innovative products, companies, and careers in health tech. The Urban Tech Hub develops programs dedicated to leveraging the power of technology to help optimize urban systems, improve government service delivery, and help cities adapt to future technologies.

Deborah Estrin, PhD

Professor of Computer Science and Associate Dean for Impact

Deborah Estrin is a Professor of Computer Science at Cornell Tech where she holds the Robert V. Tishman Founder's Chair, serves as the Associate Dean for Impact, and is an Affiliate Faculty at Weill Cornell Medicine. Estrin's research activities are in digital health technologies, including technologies for caregiving and small data. She is the founding director of Cornell Tech's Public Interest Technology Initiative.

Before joining Cornell University, Estrin was the Founding Director of the NSF Center for Embedded Networked Sensing (CENS) at UCLA, pioneering the development of mobile and wireless systems to collect and analyze real-time data about the physical world. Estrin co-founded the nonprofit startup, Open mHealth, and has served on several scientific advisory boards for early-stage mobile health startups. She served as a 2019-2020 Amazon Scholar.

Estrin is an elected member of the National Academy of Engineering, National Academy of Medicine, was chosen as a 2018 fellow of the MacArthur Foundation, and was named the 2022 recipient of the prestigious Institute of Electrical and Electronics Engineers (IEEE) John von Neumann Medal.

Nikhil Garg, PhD

Assistant Professor of Operations Research and Information Engineering

Nikhil Garg is an Assistant Professor at the Jacobs Technion-Cornell Institute at Cornell Tech. He is a member of the Operations Research and Information Engineering field at Cornell University. His research interest is the application of algorithms, data science, and mechanism design to the study of democracy, markets, and societal systems at large. He received his PhD from Stanford University in 2020, where he was part of the Society and Algorithms Lab and Stanford Crowdsourced Democracy Team. He has spent time at Uber, NASA, Microsoft, the Texas Senate, and IEEE's policy arm, and most recently was the Principal Data Scientist at PredictWise, which provides election analytics for political campaigns.

Emma Pierson, PhD

Assistant Professor of Computer Science

Emma Pierson is an Assistant Professor of Computer Science at the Jacobs Technion-Cornell Institute at Cornell Tech where she holds the Andrew H. and Ann R. Tisch Assistant Professor Chair, and a computer science field member at Cornell University. She develops data science and machine learning methods to study inequality and healthcare. Her work has been recognized by a Rhodes Scholarship, Hertz Fellowship, Rising Star in EECS, MIT Technology Review 35 Innovators Under 35, and Forbes 30 Under 30 in Science. She has written for The New York Times, FiveThirtyEight, The Atlantic, The Washington Post, Wired, and various other publications.

Urban Tech Hub

Anthony Townsend, PhD

Senior Research Associate

Anthony Townsend is an internationally-recognized expert on the future of cities and urban technology. As Senior Research Associate at the Urban Tech Hub of the Jacobs Technion-Cornell Institute at Cornell Tech, he leads the development of multi-disciplinary research collaborations, partnering university researchers with stakeholders in industry, government, and civil society. Anthony is the author of two books, *Ghost Road: Beyond the Driverless Car* (2020) and *Smart Cities: Big Data, Civic Hackers and the Quest for A New Utopia* (2013), both published by W.W. Norton & Co.

Health Tech Hub

Chethan Sarabu, MD

Director of Clinical Innovation

Chethan Sarabu trained in landscape architecture, pediatrics, and clinical informatics, builds bridges across these fields to design healthier environments and systems. He is the inaugural Director of Clinical Innovation for the Health Tech Hub attheJacobs Institute at Cornell Tech. Over the past six years, Sarabu has been a Clinical Assistant Professor of Pediatrics at Stanford Medicine and has worked in the health tech industry as Head of Product, Director of Clinical Informatics, and Medical Director at doc.ai and later Sharecare. He collaborates with the OpenNotes Lab as an AI and Informatics Strategist and serves as a board member of The Light Collective. In these roles, he has designed and implemented a wide array of innovations, including patient portals, EHR transformation, virtual clinical trials, AI-driven digital biomarkers, documentation, and health information policy initiatives, all through a lens of health equity and patient transparency.

Weill Cornell Medicine

Weill Cornell Medicine is committed to excellence in patient care, scientific discovery and the education of future physicians in New York City and around the world. Since 1898, our doctors and scientists have been engaged in world-class clinical care and cutting-edge research that connect patients to the latest treatment innovations and prevention strategies.

Arnab Ghosh, MD

2024 NIA/NIH Climate and Health Scholar, Assistant Professor of Medicine

Dr. Ghosh's research program focuses on climate change and health, and development of interventions to protect vulnerable populations against climate-amplified threats. He is also a practising internist. He is a fellow of the Atkinson Center for Sustainability and Center of Health Equity at Cornell University.

He received his undergraduate medical degree and graduate degree in development studies at the University of Melbourne, Australia, and graduate degrees in health policy, and clinical/translational sciences at Cornell University. He undertook his training in emergency medicine at the Royal Melbourne Hospital in Melbourne, Australia, and Internal Medicine at NYU School of Medicine. He continues to practice medicine, and currently serves as a Medical Officer as part of the Disaster Medical Assistant Teams within the US Government's National Disaster Medical System.

He previously served on a NAM-Burroughs Wellcome Fund panel on climate and health, and is the current co-chair of the national subcommittee of health policy and research at the Society of General Internal Medicine. Prior to his career in academia, Dr. Ghosh worked as a McKinsey consultant, a HIV/AIDS policy analyst at the United Nations Secretariat, and practiced medicine in remote, resource-limited settings as an emergency physician.

Cornell Public Health

Cornell Public Health uses a highly transdisciplinary approach that integrates understanding of the social and environmental determinants of health into our professional health practice, research, and training of public health leaders. We emphasize impact-oriented community engagement throughout our Program—in our classrooms, research, and practice—to address and improve local, regional, national, and international health issues.

Gen Meredith, DrPH, OTR

Associate Professor, Public and Ecosystem Health

Gen Meredith is an associate professor in Cornell's department of Public and Ecosystem Health, associate director of Cornell's Master of Public Health Program, co-associate director for education with Cornell's Center for Health Equity, and director of Cornell's Health Impacts Core. In these roles, Gen braids her experiences as a public health researcher and practitioner at local, clinical, state, and international levels to develop, evaluate, and improve public health systems, and to build the public health leaders of our future through teaching, capacity building, and practice-based mentoring. Gen's areas of applied research focus on improved pedagogical practices for public health workforce development; optimized public health systems utilization, with a focus on data use for decision making; institutional capacity enhancement related to integrated disease and risk surveillance and response; community capacity building for collective impact; and accessible solutions to unlock the upstream health benefits of nature engagement.

Danielle Eiseman, PhD

Health Impacts Partnership Lead

Danielle Eiseman is the Health Impacts Partnership Lead at Cornell University in the Department of Public and Ecosystem Health. She is a communications expert who centers her expertise on helping

communities design and implement interventions to increase health equity. She has worked with international policymakers on climate change policy and public engagement. In her current role, Danielle is focused on climate change impacts and action at the intersection of human health, nutritional food access, and policy, as well as reducing climate-induced health and well-being risks for vulnerable populations. She has projects focused on professional skills building in risk and crisis communication and improving resilience and health equity among vulnerable populations.

Alistair Hayden, PhD

Assistant Professor of Practice

Alistair Hayden is an Assistant Professor of Practice in Cornell University's Department of Public and Ecosystem Health, Faculty Fellow of the Cornell Atkinson Center for Sustainability, and formerly served as a Division Chief at the California Governor's Office of Emergency Services. Hayden supports practitioners in protecting the public from extreme heat and wildfire smoke through research, policy, and communications.

Ongoing Projects

In 2024, the Cornell Initiative on Aging and Adaptation to Extreme Heat launched three focused, interdisciplinary projects to apply these strategies to the challenges of understanding and intervening to improve the health of older adults in cities. Jump ahead to learn about our approach, our 2024 activities and accomplishments for each project.

Informing Public Health Response to Extreme Heat Events

Developing knowledge and tools to provide new and actionable insights for public health officials during heat waves, and to stress test state and local government heat action plans. (page 11)

Extreme Heat and Medical Needs of Older Adults

Improving understanding of the medical needs of older adults in the context of extreme heat to identify and stratify the greatest at risk, and to evaluate how emerging digital health tools can be used to adapt to these needs. (page 16)

Extreme Heat Exchange

Uniting stakeholders across sectors by creating a structured framework for technical resource sharing, software development, and cross-disciplinary collaboration to address extreme heat impacts on older adults in cities. (page 19)

Informing Public Health Response to Extreme Heat Events

The goal of this project is to develop knowledge and tools to provide new and actionable insights for public health and emergency management officials during heat waves, and to support their collective capacity enhancement to improve preparedness for preventing heat-related deaths and coordinated responses to heat emergencies.

Public health and emergency managers share responsibilities and burdens amidst weather emergencies. However, these officials face delays and gaps in the information needed to make decisions before and during extreme heat crises, and lack sufficient opportunities for collaborative preemptive action planning. In many jurisdictions, public health and emergency management staff work under different leadership organizations with different organizational norms and communication methods. Further, data about vulnerable populations and the health impacts of extreme heat events is especially poor: excess-death analyses can take up to a year, squandering opportunities to intervene. Other valuable information, such as measures of access to public health services during heat emergencies, is generally not available to public health officials.

This work seeks to support public health and emergency management officials in planning for and responding to extreme heat events. By developing a comprehensive understanding of the data and analysis needs of public health officials and emergency management, we can develop new tools and table-top scenario planning exercises to enhance collective capacities, stress test heat action plans, and identify gaps in access and service to highly-vulnerable older adults. Over time, these approaches can inform development of more robust solutions for coordinated management of climate risks.

Identifying Data Needs and Gaps

To build and 'ground truth' our understanding of public health and emergency management officials' experiences and needs related to extreme heat emergencies, we conducted eight listening sessions with 15 leaders in urban and peri-urban settings across New York State. We asked how they prepare for heat emergencies, challenges they experience, and ideas for improved preparedness, prevention, and resilience.

Officials highlighted the importance of preparedness, building resilience, and coordinating services to prevent harm during heat-related emergencies. They reported employing various methods to plan for heat emergencies, including emergency response drills, identifying resources, and coordinating across agencies. They also noted relying on various resources, including the National Weather Service, vulnerability mapping tools (e.g., CDC's Social Vulnerability Index, EPA's Environmental Justice Map), and information from the NYS Department of Health and the NYS Office of Aging.

Officials reported taking on a range of responsibilities when responding to heat emergencies, including making decisions about response, communicating with

the public, and supporting vulnerable populations and regions. To support this effort, they highlighted the importance of information sharing, health communication, and coordination to ensure cooling center operations, while also noting real challenges, including those related to transportation in emergencies, and reaching vulnerable populations. The officials noted several gaps in extreme heat preparedness and response, including data needs, and presented ideas for innovation:

- Development and socialization of an index or metric for heat risk, akin to the AQI, that is easy to interpret and takes into account factors such as 'real feel' and humidity.
- Creation of a website to visualize heat risk.
- Development of a warning system, similar to the AQI, with thresholds/levels of risk that correspond to clear actions that can be taken by public health agencies, such as pushing warnings to the general population or opening up cooling centers.
- Identification and application of more effective ways to reach constituents, particularly vulnerable populations, with information about heat emergencies.
- Augmented capacity to improve communication strategy alignment and effectiveness with vulnerable populations.
- Improved data on the health impacts of heat, such as when and where heat mortality, hospitalizations, or heat related disease incidence occurs to better inform resource distribution and communication efforts.

To expand our understanding of weather-related emergency preparedness in New York State, we conducted a survey with public health and emergency managers. Some 239 participants engaged with the survey, representing 77% of counties statewide (48/62). Respondents represented a variety of organizations, including local health departments, hospitals, and emergency services organizations. They fill various roles, including public health and/or emergency management officials (directors, managers, administrators), first responders, and educators. A majority of respondents (95%) indicated feeling prepared to handle emergencies related to snow and ice, but fewer (74%) feel prepared for events related to extreme heat, and very few (54%) feel prepared for

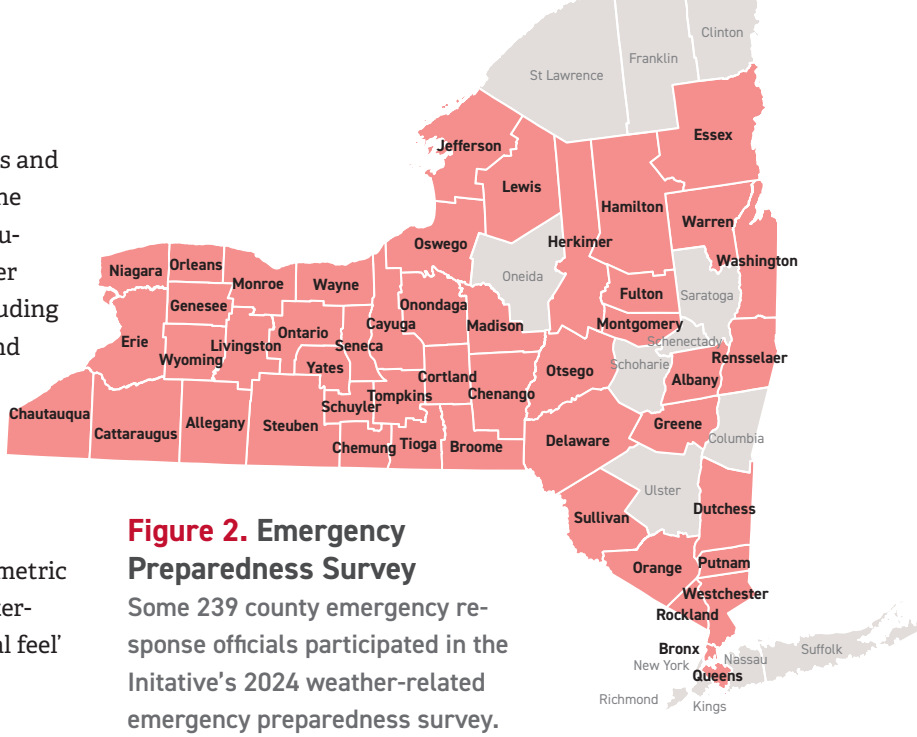


Figure 2. Emergency Preparedness Survey

Some 239 county emergency response officials participated in the Initative's 2024 weather-related emergency preparedness survey.

Source: Cornell Public Health

any event that leads to power outages. Of note, only 37% of respondents report being able to easily identify the location and needs of vulnerable populations during heat emergencies.

Reported barriers to being able to carry out emergency response duties during an emergency include insufficient resources (e.g., staffing, supplies, time, funding) (69%), staff experience/training (40%), access to/use of localized actionable data (29%), and collaboration with other local resources (23%). To help fill the noted gaps, respondents requested the following types of interventions:

- Development of an interactive map with local information on weather, social vulnerability and guidance for specific actions to take.
- Development and delivery of table-top event simulation trainings that support cross-agency and cross-jurisdiction networking
- Providing workforce development training and guidance on various topics including how to interpret weather-related data, how to use weather data to inform public health and emergency management decisions and communications, risk management, and risk communication.

Based on this sample, the public health and emergency management workforce in New York State appears eager to expand their readiness, and indicate a need for tools, training, and networking opportunities. We intend to support workforce capacity enhancement, and continue this survey as an annual "pulse check" to evaluate whether efforts to enhance community resilience are working to promote greater communication, collaboration, and coordination across agencies, organizations and jurisdictions in New York State.

Combining Federal Data Sets to Pinpoint Vulnerability

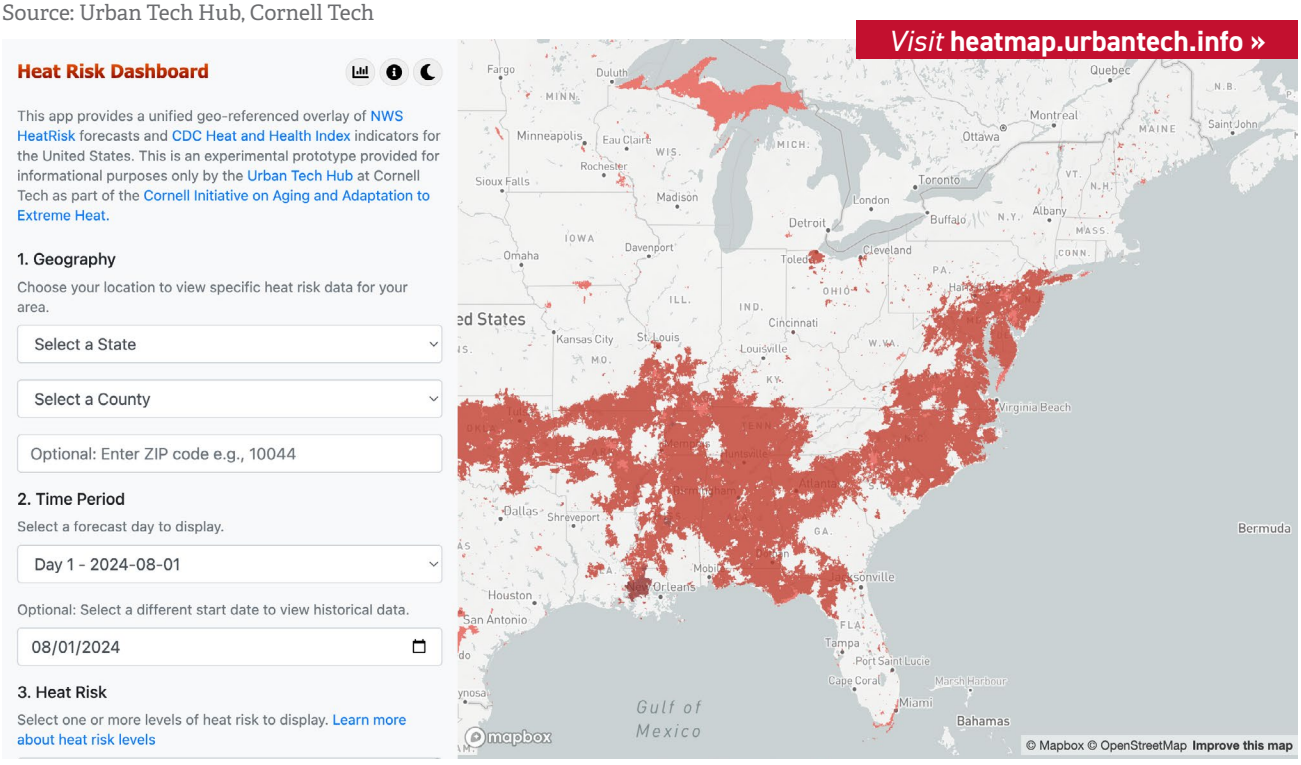
In response to the information gaps and needs identified by Cornell Public Health researchers among public health and emergency management officials in New York State, Urban Tech Hub staff created an experimental prototype web app to overlay two new federal heat risk and vulnerability data sets in a single, searchable map. These new federal data products are the NWS HeatRisk forecast and CDC Heat and Health Index. The tool allows users to filter heat risk forecasts by degree of severity and demographic and health indicators to pinpoint vulnerable groups in highly-specific geographies. A playback feature allows loading of any previous forecast, making the tool useful for tabletop exercises based on real historical events anywhere in the lower 48 states. The app is available at https://heatmap.urbantech.info/.

The demo map was shared by Cornell Public Health researchers with public health officials and policymakers across New York State, who are enthusiastic about using the decision-support tool. Future improvements to the map will include cooling center location data to help users identify the proximity of cooling centers to vulnerable populations and will help inform decisions on whether or not to move cooling centers or provide alternative interventions.

Figure 3. Pinpointing Vulnerable Populations

The Heat Risk Dashboard allows users to filter heat risk forecasts by degree of severity and demographic and health indicators to pinpoint vulnerable groups in highly-specific geographies.

Source: Urban Tech Hub, Cornell Tech



In March 2025, Cornell Public Health researchers will present at the Association of Schools & Programs of Public Health (ASPPH) conference on the needs and challenges public health and emergency management professionals face in mitigating health risks due to extreme heat, and demonstrated The Heat Risk and Health Index Dashboard and its use to support public health decision-making.

Modeling Cooling Deserts

To effectively address the placement of cooling centers within state energy agency heat action plans, it is critical to quantify and understand "cooling center deserts"—areas where access to these vital resources is lacking. By integrating comprehensive databases of facility locations with detailed census data, weather data, and quantification of "urban heat islands", we can assess the distance between population center needs and existing cooling centers. This analysis, led by Nikhil Garg and Emma Pierson, allows us to compare actual distances to those predicted by optimal facility location models, which prioritize various functions such as welfare maximization or population need considerations. Furthermore, this approach enables the identification of disparities in access across different demographic groups, geographic regions, and over time. We can also explore whether these "deserts" are a reflection of population density differences or if they point to other systemic issues. By addressing these questions at scale, the insights gained can inform more equitable placement strategies (and areas for adaptive capacity expansion) for cooling centers, ensuring that they serve the communities most in need during extreme heat events. Such an approach underscores the importance of data-driven decision-making in public resource allocation, particularly in the context of increasing climate challenges.

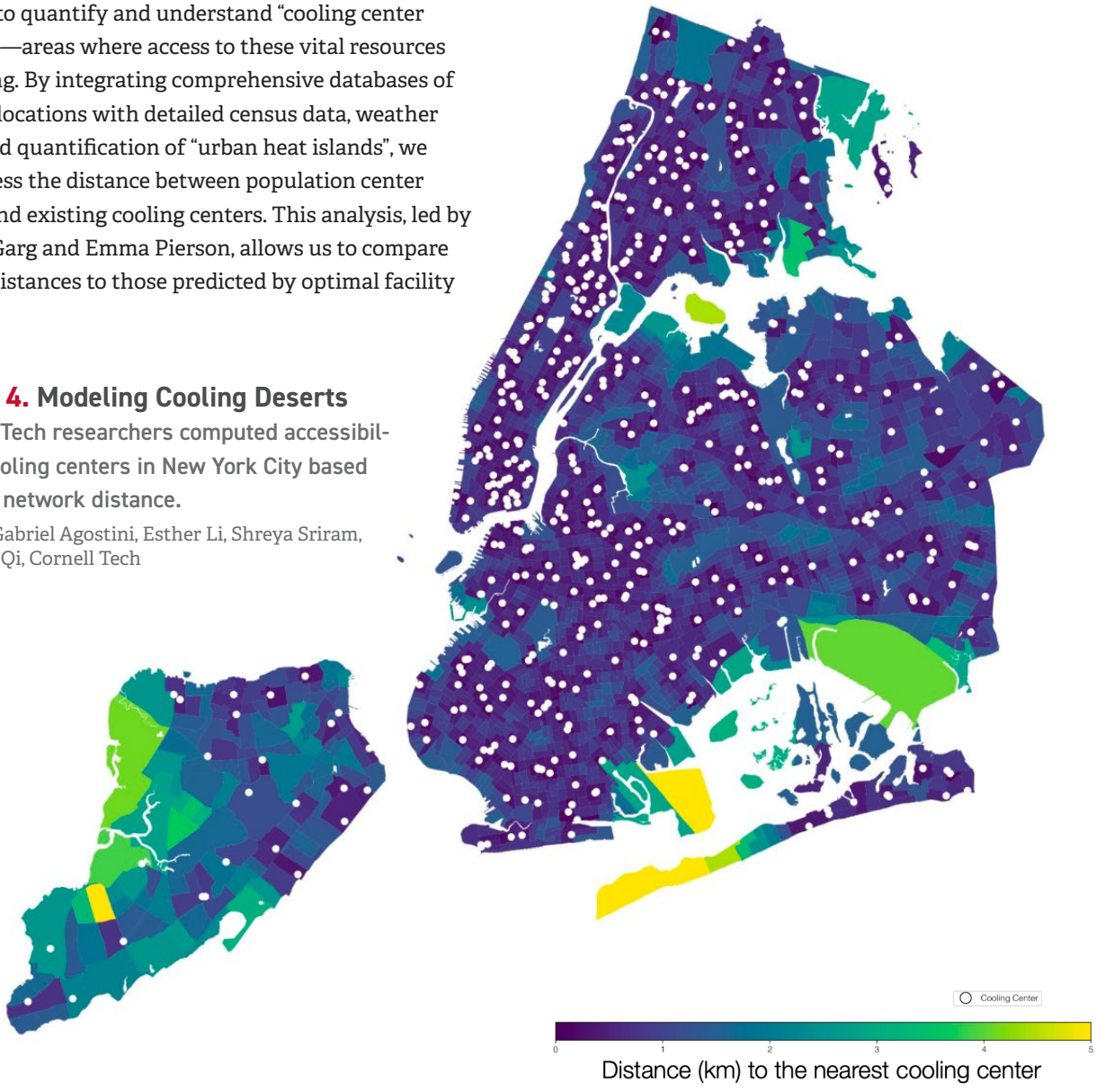


Figure 4. Modeling Cooling Deserts

Cornell Tech researchers computed accessibility to cooling centers in New York City based on road network distance.

Source: Gabriel Agostini, Esther Li, Shreya Sriram, Zhixuan Qi, Cornell Tech

Enhancing Capacities

To respond to the expressed needs of public health and emergency management workers in New York State, Cornell Public Health researchers developed and are delivering several capacity-enhancement resources:

Extreme Heat Web-Based Toolkit

This web-based resource was developed to provide individuals, community organizations, and public health and emergency management officials with easy to navigate information on extreme heat and heat emergencies, and guidance on keeping people safe during extreme heat events. This Toolkit is free to all and, to date, has been disseminated to over 500 people via newsletters and push notifications. Informational webinars are planned for Spring 2025, to help agencies and communities prepare for summer heat waves. This tool is available at https://blogs.cornell.edu/heat/.

Heat Action Plans

Cornell Public Health provides 1:1 technical assistance to help communities develop heat action plans centered around equity. This includes working with local public health and emergency preparedness coordinators and community members to assess current resources, needs, and gaps in addressing extreme heat, such as cooling centers, transportation, and outreach to determine where new interventions can be developed. Additionally, the team facilitates local convenings to build partnerships for preparedness planning to better leverage existing resources across a community to build overall resilience and preparedness.

National NACCHO Preparedness Summit

In April 2025, the team will present at the NACCHO Preparedness Summit in partnership with ESRI. Specifically, the team delivered a hands-on learning session to build public health and emergency managers' toolbox to prepare for and respond to extreme heat. The session helped workers learn how to pinpoint places that would benefit from heat mitigation efforts, with an emphasis on equitable climate action for heat and other climate-related threats, as well as effective community engagement for right-fit solutions to protecting public health

Using AI to Assess Heat Readiness

Through a partnership with Arizona State University, *Strategies for Withstanding Extreme Heat: Leveraging Tools for Readiness* (SWELT-R), Cornell Public Health and the Urban Tech Hub have jointly proposed a project to FEMA for the development of large language model (LLM) applications to catalog the state of heat action planning nationwide. This work will automate the identification and extraction of heat mitigation and other heat action planning content from a variety of state and local disaster recovery, disaster preparedness, and emergency preparedness sources. This work builds on existing Cornell Public Health manual data collection that previously identified 2,660 heat actions collected from more than 230 documents.

Extreme Heat and Medical Needs of Older Adults

The goal of this project is to improve understanding of the medical needs of older adults in the context of extreme heat, identify and stratify the greatest at risk, and to evaluate how emerging digital health tools can be used to adapt to these needs.

This work explores healthcare utilization patterns during extreme heat events for NYC residents over age 65. The primary source dataset for this analysis is the New York Statewide Planning and Research Cooperative System (SPARCS), which contains all inpatient, outpatient, and emergency healthcare utilization records for all New York City residents. Using machine learning algorithms and merged census data, the research aims to identify high-risk subgroups among the elderly population and inform targeted interventions for addressing health effects of climate-related heat events. This baseline will identify subgroups most at risk and will inform an evaluation of how emerging digital health tools can be used to further evaluate the physiological and environmental contributors to heat risk.

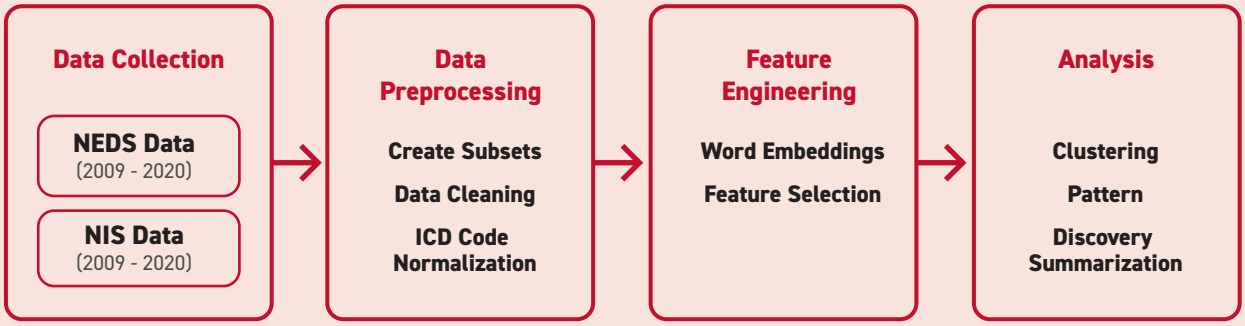
This retrospective data analysis informs the design of individualized, timely, and scalable interventions for heat-vulnerable older adults. We evaluate the use of existing and novel patient-generated digital biometrics data (digital biomarkers) for characterizing and monitoring the physiological and behavioral impacts of heat exposure, and how these data can be scalably integrated into existing virtual care services in the form of digitally-enhanced interventions. The goal of this work is a suite of experimental study designs that leverage available devices and data sources, and that are based on a common data architecture to promote modularity and ready integration of new devices as they emerge.

Cluster Analysis of Heat-Related Illness

During autumn 2024, Weill Cornell Medicine and Cornell Tech conducted a comprehensive analysis using the National Inpatient Sample (NIS) and National Emergency Department Sample to investigate comorbidity patterns associated with heat-related illness presentations. The study examined emergency department visits and inpatient admissions using both ICD-9 and ICD-10 diagnostic codes. The analysis incorporated multiple patient characteristics, including demographics (age, gender, insurance status), geographic factors (ZIP code median income quartiles, RUCA codes), and extensive diagnostic information across 33 diagnosis fields. Various dimensionality reduction techniques were evaluated, including Principal Component Analysis (PCA), Truncated Singular Value Decomposition (TSVD), and Non-negative Matrix Factorization (NMF). K-nearest neighbors (KNN) clustering was then applied, with cluster selection optimized using silhouette scores. The resulting clusters were analyzed for clinical relevance to identify meaningful patterns of comorbidities associated with heat-related illnesses.

Figure 5. Data Processing and Cluster Analysis Pipeline

Source: Yixuan Wang, Cornell Tech



Data Infrastructure for Climate and Health Equity

In November 2024, the project team submitted a manuscript to the journal *Medical Care* for inclusion in a special issue on *Building Data Capacity to Advance Health Equity for Patient-Centered Outcomes Research*. The article, "Advancing climate and health equity: Modular data-intensive system architecture to develop interventions for older adults exposed to extreme heat", builds on Initiative research and prototyping in 2024, proposing a new approach to protecting older adults from extreme heat events (EHEs). The proposed system integrates multiple data sources including wearable devices (like the Oura Ring), indoor environmental sensors, electronic health records, and various public datasets to create comprehensive individual and population-level heat risk profiles. This architecture enables real-time monitoring of physiological responses to heat, analysis of indoor versus outdoor temperature differences, assessment of heat thresholds for different health conditions, and development of targeted interventions for vulnerable populations. This data-intensive approach aims to advance health equity by supporting both individualized early warning systems and broader public health and urban systems engineering responses, particularly focusing on older adults with multiple health conditions who are most susceptible to heat-related health problems.

A prototype of this approach was assembled to integrate three data streams to investigate the relationship between indoor temperature and sleep quality. The system collects data from:

- Oura Ring API, which provides detailed sleep metrics including total sleep duration, heart rate variability, respiratory rate, and body temperature;
- Govee sensors that continuously monitor indoor environmental conditions; and,
- NOAA Weather API for contextual outdoor temperature data.

Automations move data in cloud storage, which is linked to a Jupyter Health notebook environment for linking and analysis.

In review: Arnab K Ghosh, Nikhil Garg, Emma Pierson, Chethan Sarabu, Genevive Meredith, JP Pollak, Anthony Townsend, Deborah Estrin. "Advancing climate and health equity: Modular data-intensive system architecture to develop interventions for older adults exposed to extreme heat". *Medical Care.*

Figure 6. Data sources and streams available through the proposed systems architecture

Source: Ghosh, A, et. al.. "Advancing climate and health equity: Modular data-intensive system architecture to develop interventions for older adults exposed to extreme heat", In review, *Medical Care*

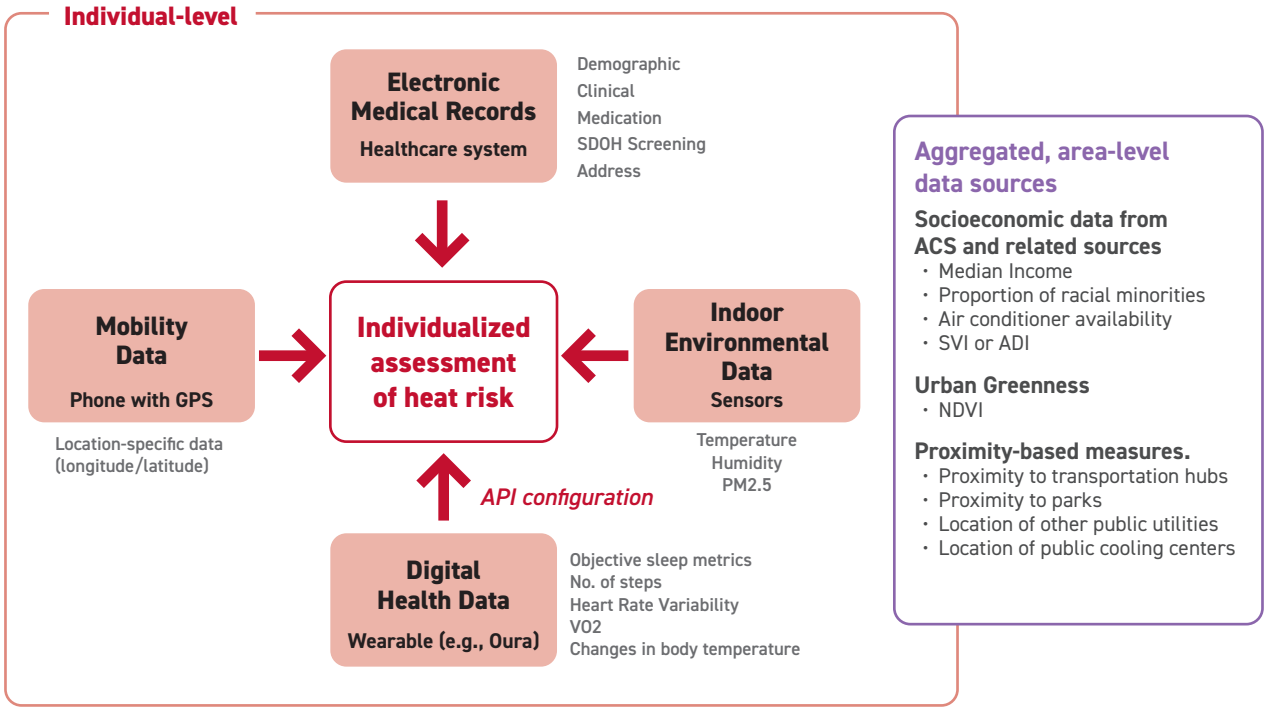
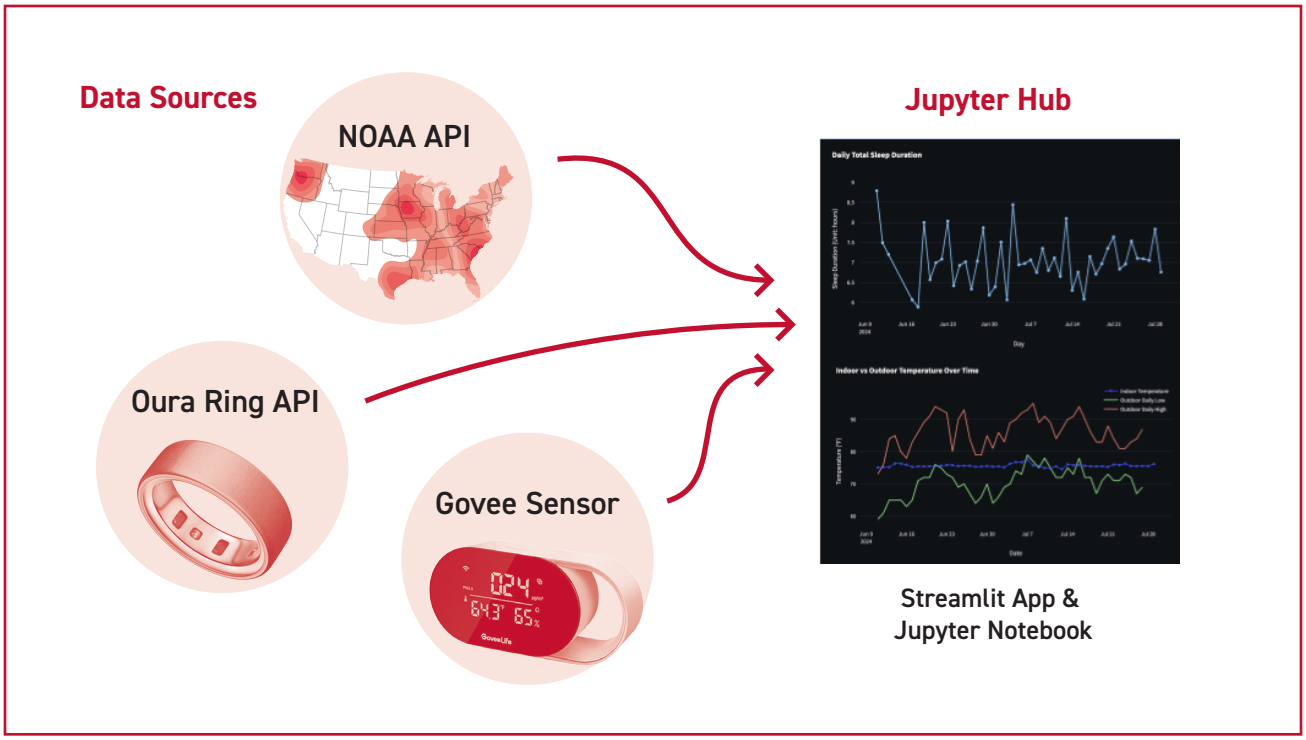


Figure 7. Data infrastructure prototype

Source: Yixuan Wang, Cornell Tech



Extreme Heat and Aging Exchange

The goal of this effort is to unite stakeholders across sectors by creating a structured framework for data sharing, software development, and cross-disciplinary collaboration to address extreme heat impacts on older adults in cities.

Effective response to the challenge of extreme heat in cities requires mobilization of multiple systems—health care, public health, and the built environment—and multiple sectors—governments, industry, and civil society. But integrating research and action across these silos introduces a new set of challenges. Some are common to climate adaptation work, which due to scale and complexity demands cooperation among many actors across multiple sectors and disciplines. Problems of information availability, access, and integration are widespread.

To address these issues, the Cornell Initiative on Aging and Adaptation to Extreme Heat creates neutral spaces where industry, government, and academics can come together in a well-defined stakeholder network to work across boundaries around a strategic public challenge. These platforms have both technical and organizational components that serve a variety of functions: defining shared priorities and problems, disseminating information about effective solutions, establishing and enforcing rules to facilitate data and model exchange, creating software and standards, and generating new collaborations.

Cataloging Data, Visualizations, and Models

To create a catalog of technical resources supporting interdisciplinary research and action, we developed a website and content management system that allows for curation and publication of references to data sets, data portals, data visualizations, code repositories, and publications. Resources are tagged with metadata describing relevant geography, time period, and origin. The resource portal is available at https://www.extremeheat.us.

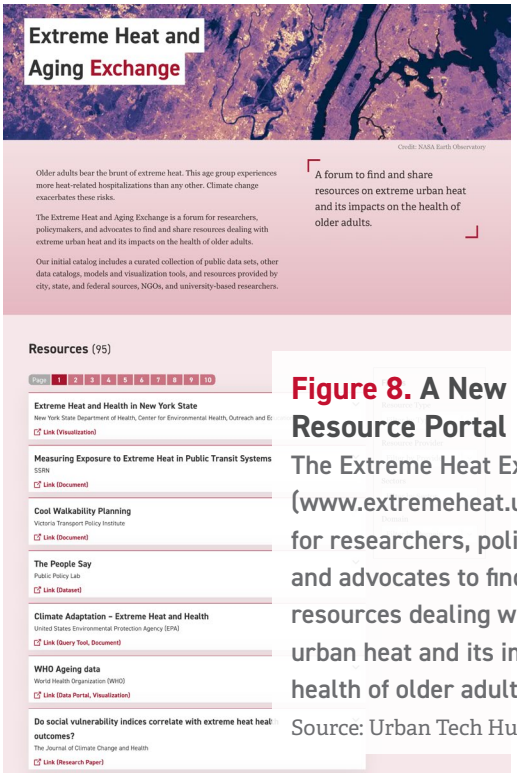


Figure 8. A New Resource Portal
The Extreme Heat Exchange (www.extremeheat.us) is a forum for researchers, policymakers, and advocates to find and share resources dealing with extreme urban heat and its impacts on the health of older adults.
Source: Urban Tech Hub, Cornell Tech

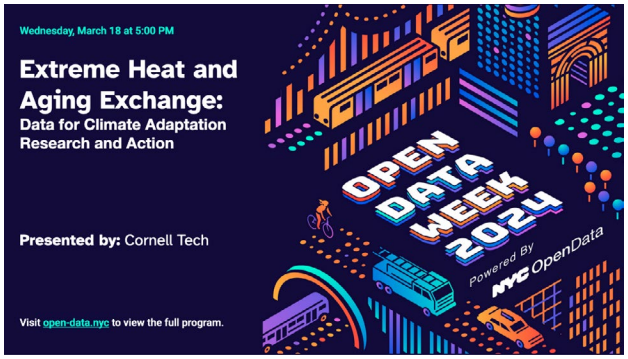
Visit **extremeheat.us** »

Engaging Open Data Networks

On March 18, 2024, the project team organized and conducted a public forum as part of New York City Open Data Week, on the theme of "Extreme Heat and Aging Exchange: Data for Climate Adaptation Research and Action". This event served as a public launch for the Exchange and was attended by over 120 participants, representing New York State and New York City governments, as well as industry and non-profit organizations.

Figure 9. Open Data Week

Initiative researchers hosted a virtual workshop during NYC Open Data Week 2024 to launch the Extreme Heat Exchange.



Source: New York City, Mayor's Office of Technology and Innovation

Informing An Applied Research Community

To sustain engagement with the Exchange, we publish a monthly newsletter reaching some 140+ stakeholders in the New York metro area. These mailings provide links to new data sets, models, and research articles cataloged in the Exchange.

Figure 10. Monthly Research Newsletter

The Initiative is a source of information on new data sets, models, and research articles on extreme heat and older adults.

JUNE 2024

EMS Data, Phoenix's Heat Relief Network, and A New Lit Review on Climate Impacts and Older Adults

May 2024 clocked in as the world's hottest month on record, and global warming now exposes us to nearly a month's more abnormally hot days. Despite the mounting challenge, a groundswell of important work to address the impacts of extreme heat on older adults continues to build.

This month's additions to the Extreme Heat and Aging Exchange include:

- **National heat-related EMS response data**: Visualize or download nationwide, county-level data on heat-related EMS activations (2-week lag) from the National EMS Information System (NEMSIS)
- **Climate impact projections tool:** The Climate Explorer, built to support the U.S. Climate Resilience Toolkit, provides interactive graphs and maps showing past and projected climate conditions for counties and county-equivalents across the United States.
- **Heat relief network map:** An interactive map of the Phoenix metro area's Heat Relief Network shows how a regional partnership municipalities, nonprofit organizations, faith-based organizations, and businesses can be mobilized to provide hydration stations, refuge locations, and water donation sites.
- **Research review flags big gaps around climate impacts on older adults:** A new review in the *Journal of Global Health* finds insufficient primary research on the impact of climate hazards on older people, and that future research "should include outcomes beyond mortality and morbidity and assess how older people interact with their environment by focusing on their capacities and optimising abilities for being and doing what they value."

The Exchange is a resource for researchers, policymakers, and advocates coping with the impacts of extreme heat on older adults in New York City and beyond.

Please suggest additional resources here!

Source: Urban Tech Hub, Cornell Tech

Figure 11. A Growing Ecosystem for Research and Action

Monthly newsletters are helping to build a broad-based community of research and action on the needs of older adults facing extreme heat.

Source: Urban Tech Hub, Cornell Tech