Insights and Research Priorities from NOAA's Extreme Heat Social Science Community of Practice

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Under the Leadership of NOAA's Social Science Committee

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Executive Summary

Extreme heat is the leading cause of weather-related fatalities in the United States and poses a considerable threat to public health and society as a whole. Its impacts—ranging from heat illness and mortality to power grid and transportation stresses—are shaped by sociodemographic and economic factors, pre-existing health conditions, housing and infrastructure, and access to resources. As our nation experiences increases in the frequency, duration, and intensity of extreme heat events, there is an urgent need to better understand and coordinate NOAA's efforts to address the human dimensions of this hazard.

In 2024, NOAA's Climate Program Office and Weather Program Office launched the **Extreme Heat Social Science Community of Practice (CoP)** to strengthen coordination, identify research priorities, and establish a community of researchers and practitioners with shared interests. This cross-NOAA effort was created under the NOAA Social Science Committee to provide a forum for researchers and practitioners to exchange insights, share tools, and guide future research on extreme heat and its societal impacts.

Over the course of ten meetings (April 2024–June 2025), the CoP convened 25 members—including federal employees, NOAA affiliates, and external researchers—across four NOAA line offices. Presentations spanned topics such as heat risk communication, vulnerability assessment in U.S. territories, economic and health impacts, and an overview of NWS' heat products and services. This interdisciplinary exchange helped surface common challenges, foster collaboration, and spotlight areas in need of deeper study.

Key Research Priorities Identified:

- Test the effectiveness of extreme heat messages across different audiences.
- Support extreme heat research capacity in U.S. territories and islands.
- Evaluate the impact of NWS extreme heat products and services, focusing on usability and effectiveness among specific end users.
- Investigate cascading and compound hazards involving extreme heat.
- Strengthen data linkages among social, meteorological, geographical, and public health sciences.

Additional Highlights and Needs:

- Coordination and knowledge sharing remain critical to enhance leveraging and promote shared use of research instruments and publicly available data.
- Extreme cold was identified as an emerging area needing more social science research, particularly around risk communication, public perception, and response.
- Bridging the weather and climate timescales is essential to fully address the wide-ranging impacts of extreme heat and to build more resilient communities.

Introduction

Although the impacts of extreme heat are not as visible as other hazards like hurricanes or floods, its effects on society are equally tangible and observable. Extreme heat is the leading cause of weather fatalities in the United States and poses a considerable threat to public health. Heat impacts vary widely based on sociodemographic factors (age, income,etc.), availability of air conditioning, pre-existing health conditions, and so forth. Moreover, according to the fifth National Climate Assessment, “The frequency, intensity, and duration of extreme heat have increased. Across all regions of the US, people are experiencing warming temperatures and longer-lasting heatwaves.”

With heat and its cascading impacts on the rise, and with asynchronous but important heat-related work happening at NOAA, in 2024, the Climate Program Office and the Weather Program Office began discussing ways to work more collaboratively on these efforts. It became clear there was a need to better understand what extreme heat-related initiatives and projects were happening across and outside of NOAA, in order to both avoid duplication and to ensure best practices. After drafting the terms of reference, NOAA established a community of practice (CoP) for extreme heat social science, under the auspices of the NOAA Social Science Committee to help NOAA continue to produce high quality research and provide services that are effective by understanding how decision-makers (e.g., the public, state and local governments, etc.) and federal partners understand and use heat information.

The NOAA CoP aimed to facilitate the exchange and interpretation of social science knowledge, engagement, and research on extreme heat amongst NOAA practitioners; provide a forum for discussion of common problems and issues; act as a valuable resource for advice on issues related to the human dimensions of extreme heat; encourage communication and collaboration between researchers; and establish a community of researchers and practitioners at various career stages with shared interests, contributing to the advancement and use of extreme heat social science research within NOAA.

The three goals of this CoP were:

- Advance basic and applied social science knowledge surrounding heat and identify research gaps and priorities using NOAA-funded research and insights from relevant scholarly literature to ensure that heat and social science are integrated into other forums and plans in the agency and interagency context.
- Create a space for interdisciplinary knowledge exchange between social, physical, and health scientists, as well as practitioners both internal and external to the agency.
- Evaluate the effectiveness of service delivery in the heat domain, while also measuring progress and assessing the impact of future improvements.

The first meeting was held on April 22, 2024, and, as of June 2025, ten meetings have been held. These meetings have been member-driven, providing a virtual space for researchers and

practitioners to share insights about their projects and explore opportunities for collaboration aimed at producing tangible outputs and outcomes.

Members

The CoP recruited members through the NOAA Social Science Committee and through word of mouth and connections with other NOAA-funded or affiliated researchers and partners. Members include scientists and practitioners from inside and outside the agency, with a focus on enhancing interaction and coordination among physical science, social science, and health sciences. The group consists of NOAA staff and affiliates studying the societal impacts of heat, program staff supporting extreme heat research, practitioners witnessing on-the-ground heat-health impacts or addressing policy challenges, and other individuals interested in exploring the intricate relationship between extreme heat, social science, and health sciences.

To date, there are 25 members - 7 outside of NOAA and 18 NOAA federal employees or affiliates. The group itself is led by one NOAA staff and one NOAA affiliate in NOAA Research, the Climate & Health Program Manager in the Climate Program Office and the Portfolio Analysis & Transition Lead in the Weather Program Office. Overall, the group represents four line offices (6 in the Office of Atmospheric Research, 6 in the National Weather Service, two from the National Ocean Service, and two from the National Centers for Environmental Information under NESDIS).

Reflections on Presentations

The group heard from a variety of presentations over the last 14 months. Some members presented their findings on research, whether their own work or grant-funded projects, while others invited guest speakers to share relevant information. The main presentations were:

- “Heat Vulnerability Index Assessment in the City of Ponce, Puerto Rico” by Laura T. Cabrera-Rivera, University of Puerto Rico & the NOAA CAP/RISA Caribbean Climate Adaptation Network
- “Bridging the Gap between National Weather Service Heat Terminology and Public Understanding” by Dr. Micki Olson, University of Albany at SUNY
- “Pregnant People’s Weather Information Use: Analysis of Preliminary Survey” by Dr. Lisa Zottarelli, University of Tennessee at Knoxville
- “Proposed Methodology for the Caribbean Heat Vulnerability Survey” by Dr. Lindonne Telesford, St. George’s University
- “Ethnography on heat and household economy” by Dr. Josiah Heyman, University of Texas-El Paso
- “Extreme temperatures and the cost and quality of care at HRSA-funded health centers” by Dheeya Rizmie, Mathematica
- “Extreme Heat Social Science & Behavioral Science Research” by Alexis St. Juliana of Abt Global, Joyce Coffee of Climate Resilience Consulting, Danielle Nagele of the National Weather Service, and Kim McMahon of the National Weather Service

- "An Overview of the National Weather Service's HeatRisk tool and the Census Bureau's Community Resilience Estimates for Heat" by Jared Rennie of NCEI and Kim McMahon of the National Weather Service
- "Weather Program Office-Funded Extreme Heat Social Science Efforts" by Castle Williamsberg of NOAA's Weather Program Office

These presentations were quite diverse, spanning disciplines, topics, and geographies. From how to better communicate heat to a wide variety of audiences to developing heat vulnerability levels in the Caribbean to how extreme temperatures impact the cost and quality of care at health centers, these presentations spurred robust conversations and follow-up questions. NOAA staff were able to present on their own programmatic updates and new tools, such as HeatRisk, the Community Resilience Estimates for Heat, as well as WPO and NWS-funded social behavioral science research. It allowed recent graduates and early career researchers to share their work and make connections with more tenured researchers and federal scientists. Moreover, these presentations and discussions highlighted the need for increased efforts in this field and the importance of further interdisciplinary collaboration.

Key Research Priorities Identified:

Based on the conversations, presentations, and discussions within the CoP over the past year, the following recommendations for future research and coordination are presented. However, it's important to note that this list reflects the input from the CoP and is not intended to be exhaustive of the entire Weather, Water, and Climate Enterprise. As new and emerging research areas are identified by the CoP, additional research needs will be incorporated into this list:

- **Test the effectiveness of extreme heat messages across different audiences:** Over the past decade, particularly in the last three years, both internal and external NOAA-funded research has focused on evaluating public reception, understanding, and response to extreme heat forecasts and warnings. Scholars presenting this work highlighted key challenges in how different groups (e.g., elderly populations, pregnant people) interpret and act on extreme heat messages. Therefore, they emphasized the urgent need to rigorously test the effectiveness of extreme heat warnings and public safety messages across various audiences. Experimental approaches, such as A/B testing and randomized message experiments conducted through surveys, can help identify which messages or message features resonate most effectively with different audiences. These insights could be critical in refining risk and warning communication strategies, and ensuring that extreme heat messages improve comprehension, preparedness, and prompt protective actions among the American public.

- **Support extreme heat research capacity in U.S. territories and islands:** Researchers from U.S. territories, such as Puerto Rico and the U.S. Virgin Islands, as well as other Caribbean countries, have highlighted the significant and unique heat challenges these areas face, including geographic isolation and limited infrastructure.

Despite these challenges, social science research on extreme heat in these regions remains limited. Presentations indicated that while several initiatives are in the early stages, more efforts are needed to collect baseline data to assess whether the extensive research conducted in the contiguous United States and other countries is applicable to these islands and vice versa. Expanding these initiatives is essential to ensure that all Americans, including those in U.S. territories, can understand and respond effectively to extreme heat warnings and messages and prepare effectively for future extreme heat events.

- **Evaluate the impact of NWS extreme heat products and services, focusing on usability and effectiveness among specific end users.** Presentations from the NWS revealed several new products and services, including the experimental HeatRisk tool and Wet Bulb Globe Temperatures product, designed to aid NWS partners in their decision-making processes. However, engagement with these new tools by end users has been limited. Both researchers and practitioners emphasized the growing need to systematically evaluate how key heat stakeholders—including military personnel, athletic trainers, outdoor workers, rural and agricultural workers, and school or daycare administrators—learn about, understand, and use these tools in their decision-making. Efforts could include usability testing, think-aloud protocols, heuristic evaluation, and incorporate iterative feedback loops to use user-centered design to iterate on these products and services.

- **Investigate cascading and compound hazards involving extreme heat:** Many presentations and discussions emphasized the need to shift from a single-hazard focus to understanding how hazards can act as both triggers and outcomes in cascading and/or compound hazard events. Without viewing these hazards as an interconnected system, effectively communicating risks and suggesting appropriate protective actions will remain challenging. Research should explore how extreme heat interacts with other hazards and impacts—such as hurricanes causing power outages resulting in a lack of access to air conditioning or wildfires causing poor air quality and exacerbating health impacts— as well as with sociodemographic and economic stressors and explore the implications for emergency planning, risk communication, and infrastructure resilience.

- **Strengthen data linkages between social, meteorological, geographical, and public health sciences:** Discussions that spurred from conversations during the CoP often centered around an important theme: We need better integration of meteorological data, social science data, and health outcome data (e.g., ER Visits, pregnancy outcomes, chronic illness exacerbations) to quantify the human and societal costs of extreme heat and explore options for enhanced preparedness. However, achieving this integration is challenging. It requires forging new partnerships—such as with health departments, hospitals, and CMS—and, more importantly, overcoming obstacles related to data access and quality. Despite these challenges, the potential benefits of integrating these diverse data sources could be substantial, leading to more accurate assessments of extreme heat impacts and improved public health interventions.

Additional Highlights and Needs:

While not explicitly identified as future research areas in extreme heat social science, several important needs emerged from our discussions that are worth highlighting for the social science community:

- **Coordination and knowledge sharing remain critical to avoid duplication and promote shared use of research instruments and publicly available data:** While no presentations specifically addressed this topic, nearly every conversation highlighted the importance of coordination within the community. Participants frequently recommended connecting with specific individuals or reviewing others' survey instruments. Some even shared their instruments in advance of their release to gather feedback from the community. Overall, it was clear that continued coordination is crucial, particularly in raising awareness about relevant data instruments and available data, to avoid duplication of efforts and foster collaboration. There are also other NOAA-funded projects focused on heat and social science that should be brought into the conversation going forward.

- **Extreme cold was identified as an emerging area needing more social science research, particularly around risk communication, public perception, and response:** While outside the primary focus of this CoP, discussions over the past year have highlighted the increasing emphasis on extreme cold temperatures. While most social and behavioral science research has centered on extreme heat, there is a growing recognition of the importance of exploring extreme cold and its societal impacts. Future research should investigate public perceptions, comprehension, and responses to extreme cold forecasts and warnings. This topic warrants exploration in both colder-climate regions, where preparedness may be lower despite significant risks, and warmer-climate regions, where a lack of acclimatization could lead to greater impacts.

- **Bridging the weather and climate timescales is essential to fully address the wide-ranging impacts of extreme heat and build more resilient communities:** Extreme heat spans both short-term, weather-driven events and long-term climate trends, each of which presents distinct research needs, decision-making contexts, and communication challenges. Yet, effective hazard mitigation, preparedness, and response require coordinated efforts across these timescales. Because extreme heat sits uniquely at the intersection of weather and climate, it demands stronger integration across programs and disciplines to enhance leveraging, increase the relevance and applicability of research, and support more comprehensive risk management strategies. A truly cross-timescale coordination effort is essential to fully address the wide-ranging impacts of extreme heat and to build more resilient communities.

Conclusion

Through its first year, the CoP has laid a strong foundation for NOAA and its partners to better understand, communicate, and respond to extreme heat risks. Ongoing coordination,

interdisciplinary research, and user-focused research will be key to advancing NOAA's capabilities and ensuring that all communities are better equipped to adapt and respond.

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