Severe Weather and Infrastructure:

A Case Study in Communicating Extreme Heat Risks with Public Health Professionals

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Abstract

Public-facing weather forecasters, such as those with the National Weather Service (NWS) in the United States, must quickly convey complex information about service disruptions and public health risks during severe weather events to protect community well-being. Extreme heat is one type of severe weather event that severely strains infrastructure systems—such as healthcare services and emergency alerts—particularly in historically underserved and socially vulnerable communities (HUSVCs). Drawing on an interdisciplinary project focused on developing heat-health messaging and informed by perspectives from public health professionals, this chapter demonstrates how effective communication can manage uncertainty, ensure equitable access to life-saving services, and strengthen public safety during infrastructure crises in times of severe weather.

Keywords: severe weather, infrastructure communication, extreme heat, public health professionals, historically underserved and socially vulnerable communities, HUSVCs

Severe Weather and Infrastructure:

A Case Study in Communicating Extreme Heat Risks with Public Health Professionals

Severe weather events, including hurricanes, floods, and extreme heat, place enormous pressure on critical infrastructure systems. Infrastructure—from power grids and water distribution systems to transportation networks and healthcare facilities—is rarely top-of-mind until it is at risk of failing. Yet, as climate change drives more frequent and intense extreme weather events, their interplay with infrastructural integrity becomes increasingly pressing. Extreme heat, while less visually dramatic than storms or floods, poses one of the most severe risks to public health and infrastructure operations (Errett et al., 2023). This hazard can reduce the performance and reliability of energy grids, undermine transportation services, and most critically, strain healthcare systems that must respond to surging heat-related illnesses (Mahmoud et al., 2024). Historically underserved and socially vulnerable communities (HUSVCs) face disproportionate infrastructure-related challenges during extreme heat events (Robertson et al., 2024). These communities often have lower access to healthcare, limited adaptive capacity, and may reside in areas more prone to urban heat island effects or have substandard housing that lacks adequate cooling.

To mitigate these risks, accurate and timely communication about infrastructure status, service disruptions, and protective actions is essential. Public-facing weather forecasters, such as those in the National Weather Service (NWS) in the United States, serve as crucial communicators at the forefront of this challenge. They must interpret complex meteorological data, anticipate infrastructural impacts, and translate these insights into accessible, actionable messages (National Weather Service, 2024a). These messages, in turn, must empower local stakeholders—emergency managers, healthcare providers, community organizations, and the

general public—to make informed decisions that protect health and safety (VanderMolen et al., 2022).

This chapter explores the role of communication in managing severe weather impacts on infrastructure through the lens of extreme heat. Drawing on a multi-year interdisciplinary project focused on developing heat-health messaging in the Southeastern United States, we spotlight a case study from the Columbia, South Carolina, USA area. There, a public health preparedness coalition—comprising hospitals, nursing facilities, public health agencies, and emergency management services—provided critical insights into how health sector professionals perceive and use weather information. Our exploratory analysis of coalition member survey data reveals that while temperature and heat index measures dominate current decision-making, understanding of more nuanced metrics like Wet Bulb Globe Temperature (WBGT) is limited. WBGT is a composite measure that incorporates temperature, humidity, wind speed, sun angle, and cloud cover to provide a more accurate representation of the environmental conditions affecting human heat stress. By accounting for these factors, WBGT offers a more direct link to physiological heat stress, potentially guiding more effective interventions. Analyzing the coalition's responses highlights key communication gaps and opportunities, including participants' interest in receiving more frequent and easily interpretable updates, learning about community-based cooling resources, and accessing regionally relevant information to improve patient care and preparedness. These findings underscore the importance of equipping public-facing forecasters and allied communicators with the best practices, formats, and tools to convey complex information in ways that resonate with different sectors and communities.

The chapter proceeds as follows. First, we contextualize the relationship between severe weather and infrastructure, with an emphasis on extreme heat and healthcare systems. Next, we

introduce the study setting and methodology, describing how we collaborated with a public health preparedness coalition to assess current communication practices. We then present key findings and insights from the survey data, including healthcare professionals' perceptions of various heat metrics and their preferred channels and formats for receiving updates. We illustrate that, while healthcare professionals recognize the severity of heat-related threats, their current decision-making frameworks lean heavily on basic measures and could be enhanced by more targeted, context-aware communication strategies. Finally, we discuss how these insights can inform improved communication models that bridge the gap between meteorological complexity and community needs, ultimately building more resilient infrastructure systems and better-protecting HUSVCs during times of crisis.

Severe Weather, Infrastructure, and Vulnerable Communities

Severe weather events are becoming increasingly frequent and intense due to climate change. Hurricanes spawn unprecedented storm surges, floods become more frequent and widespread, and heat waves last longer and reach more extreme temperatures. Infrastructure systems—power grids, water and wastewater treatment facilities, roads and bridges, communication networks, and healthcare systems—form the backbone of community functioning. They enable access to essential services, support economic well-being, and foster community resilience. Yet, their often-invisible nature and the complexity of their operation make them difficult to manage during rapidly evolving crises.

Extreme heat events present a unique set of challenges. Prolonged high temperatures stress electrical grids, increasing the risk of blackouts as air conditioning use surges (Burillo et al., 2016). Roads can buckle, rail tracks can warp, and water supplies can dwindle or require conservation measures (Mulholland & Feyen, 2021). Most critically, healthcare systems face

both a rise in patient load due to heat-related illnesses—such as heat exhaustion and heat stroke—and potential disruptions to power and cooling infrastructure necessary to maintain safe hospital and medical environments (Curtis et al., 2017). In areas already struggling with access to healthcare or facing chronic disinvestment, these additional stressors hit harder.

HUSVCs often live in neighborhoods that are hotter than surrounding areas, partly due to higher impervious surfaces, fewer green spaces, and housing stock that is less energy efficient (Hsu et al., 2021). Such areas may be "data deserts" for meteorological observations, meaning forecasters and emergency management professionals rely on sparse information that may not capture localized conditions (Wilhelmi & Hayden, 2010). Without accurate localized forecasts and outreach tailored to these settings, the public remains unaware of impending risks and ill-prepared to adopt protective behaviors. Additionally, given that many of these communities are multilingual and culturally diverse, advisories should incorporate multiple languages and culturally relevant messaging to ensure accessibility and comprehension.

Another complexity lies in communicating probabilistic information and uncertainties inherent in weather forecasts. Communicators must translate dynamically changing meteorological data into actionable guidance that helps different sectors make informed choices. For example, healthcare providers need to know not only that the temperature will be high but what it means for their patient populations—especially those with chronic conditions like diabetes or cardiovascular disease, which can exacerbate vulnerability to heat stress (Wondmagegn et al., 2019). This intersection—where severe weather meets stressed infrastructure and vulnerable communities—underscores the importance of real-time, accessible, and culturally sensitive risk communication (Clark et al., 2019). When done well, communication helps create a cohesive response among diverse stakeholders, ensuring that

infrastructure disruptions are mitigated, resources are allocated equitably, and at-risk populations have the knowledge and tools to stay safe (Finucane et al., 2020).

Case Study Context: The Public Health Preparedness Coalition in Columbia, SC

Columbia, South Carolina, USA, and the broader "Midlands" region, which encompasses the central part of the state, include a mix of urban centers and rural landscapes, creating a diverse setting for examining how severe weather information is communicated and understood across different community contexts. The area routinely experiences hot, humid summers, and extreme heat events could become more common (Hohlfeld, 2024). The National Weather Service's Columbia (CAE) forecast office issues heat advisories and warnings when temperatures or the heat index rise to dangerous levels. Yet traditional metrics—such as temperature alone or the heat index—may not fully capture the physiological stress that individuals, especially vulnerable patients, experience (Patel et., 2013).

Against this backdrop, we engaged with a regional public health preparedness coalition. Comprised of various healthcare stakeholders, including hospitals, nursing and long-term care facilities, emergency management and public safety agencies, and public health organizations, the coalition represents a critical audience for NWS communications. These professionals, in turn, play a vital role in preparing their organizations and communities for heat-related risks.

Our research team conducted a survey among coalition members to understand how they interpret and use weather-related information, particularly during extreme heat events. The survey asked about familiarity with different heat metrics, perceived utility of those metrics, trust in various communication formats, desired frequency of updates, and suggestions for additional content that could improve their capacity to respond to heat stresses. This approach allowed us to capture a cross-section of communication practices and priorities within the healthcare

infrastructure sector. The coalition's feedback would ideally inform the development of more tailored forecasts and messaging strategies to ensure that healthcare organizations—and, by extension, the populations they serve—can better anticipate and respond to severe heat conditions.

Method

We designed an online quantitative survey with several open-ended questions to gain insights into how healthcare professionals and emergency managers understand and apply weather information. Respondents were asked about the types of weather metrics they use (temperature, humidity, heat index, WBGT), their familiarity with these concepts, and their perceptions of the usefulness of each measure in decision-making and preparedness planning. We also investigated how respondents interpreted a sample heat advisory graphic provided by the NWS. The survey, approved by the Institutional Review Board (IRB) of the university affiliated with the authors, explored the platforms and communication channels participants found most useful, the frequency of updates they preferred, and the types of additional information that would enhance their ability to respond effectively to extreme heat events.

The survey sample included representatives from four primary organization types: hospitals, emergency management/public safety, nursing and long-term care facilities, and state and local government public health agencies. The total survey size (n = 32) included these sectors plus a few respondents from other related organizations. Although relatively modest in size, the sample provided a window into an important segment of the local healthcare infrastructure—those tasked with safeguarding public health during extreme heat. It also represented a sizable portion of the coalition's total membership. Access to the coalition's full email listserv was negotiated in May 2024, and the survey URL was distributed through an initial

recruitment message, followed by two additional reminders to encourage participation. Given the exploratory nature of this study, the sample serves as a meaningful starting point for understanding this sector's perspectives and needs.

By synthesizing survey responses, we identified patterns in how these professionals understand heat measures, what challenges they face in interpreting advisories, and what they need from forecasters. Importantly, the data also allowed us to pinpoint opportunities for bridging communication gaps—such as improving the clarity and accessibility of graphics, providing more localized data, and including actionable guidance like the location of cooling shelters and community resources.

Findings

Familiarity with Heat Metrics: From Basic Temperature to WBGT

A central finding was that healthcare professionals rely heavily on basic temperature metrics and heat index values. Traditional measures—temperature alone or the "feels like" temperature (commonly the heat index)—dominated their decision-making. The survey showed that temperature and heat index were considered the most useful by respondents, more so than humidity or WBGT.

When asked about the Wet Bulb Globe Temperature (WBGT), a measure more directly linked to physiological heat stress, a high proportion of respondents were either unfamiliar with it or did not perceive it as useful. About 32% of participants said WBGT was "not at all useful," a notable figure since no other measure received this level of dismissal. This gap in understanding suggests that while WBGT could enhance the ability of healthcare professionals to anticipate the severity of heat events on patient populations, it remains underutilized due to low awareness and unclear perceived benefits.

Given that WBGT considers multiple factors—temperature, humidity, wind speed, sun angle, and cloud cover—it can provide a more accurate measure of physiological heat stress (Brimicombe et al., 2023). If healthcare professionals were more aware of WBGT and had training in its interpretation, they could make more informed decisions about staffing, patient education, and the mobilization of resources. However, simply introducing this metric without guidance or context may not be enough. The data suggest a need for targeted communication strategies that explain why WBGT matters and how it differs from more familiar metrics.

Reliance on Basic Temperature Metrics

The coalition's responses confirm that current practices lean on straightforward, easily understandable metrics. While simplicity has its advantages, it can also obscure important nuances. A basic temperature reading does not account for humidity or solar radiation, factors that profoundly influence how quickly the human body loses its ability to cool itself.

The survey data showed that the four most common organization types (hospitals, emergency management/public safety, nursing, and public health agencies) predominantly used temperature and heat index. Humidity and WBGT trailed behind in usage. The preference for familiar measures underlines the challenge of introducing new or more complex metrics. Communicators must carefully consider how to effectively present and explain these metrics, possibly through comparative examples, training modules, or tools that integrate WBGT into user-friendly dashboards.

Interpreting Heat Advisory Graphics and Communication Materials

Because the NWS does not provide a standardized template for heat advisory graphics, we developed a prototype advisory image to gather initial feedback before engaging in more formalized message-design testing. Participants were asked to assess its clarity, accessibility, and

overall effectiveness. Most (73%) reported clearly understanding the primary warning, while an additional 24% said they 'probably' understood it. Although these figures suggest relatively strong comprehension, it is concerning that the message was not universally clear—especially since all participants were healthcare professionals within this coalition. In addition, only 56% strongly agreed they would share the advisory with someone in the affected area.

Among their suggestions was the need to clarify the 'Forecast Challenges' section—which aimed to outline uncertainties, such as the timing and coverage of potential thunderstorms that could lower temperatures—and to present this information using plainer language and alternate text for accessibility. They also recommended adjusting the geographic framing of the map so that viewers less familiar with the area could more easily orient themselves. These insights underscore that successful risk communication is not only about providing accurate, timely forecasts, but also about conveying them in formats, languages, and graphics that diverse audiences can readily interpret, trust, and act upon.

Desired Additional Information: Beyond the Weather Data

The survey asked participants what additional resources would be helpful to include with the forecast. "Information on Community Resources" emerged as the top choice, cited by 22 respondents. Over half (53.1%) also selected the inclusion of cooling station locations. These insights suggest that healthcare professionals find it valuable to connect meteorological data with practical, on-the-ground resources that can help communities cope with extreme heat.

Such information could guide healthcare professionals in advising patients on how to stay safe. For instance, hospital personnel could inform patients discharged during a heat advisory where to find cooling centers. Similarly, public health agencies could use this data to proactively communicate with higher-risk populations, ensuring access to water, shaded areas, or medical

advice. By integrating infrastructure-related elements—such as the status of cooling shelters or emergency response plans—into the forecasts, communicators can bridge the gap between pure weather data and actionable community support.

Frequency of Updates and Communication Channels

Respondents also weighed in on how frequently they preferred forecast updates. About 37.5% indicated they would find every four hours most useful. This desire for relatively frequent updates underscores the dynamic nature of extreme heat events, where conditions can rapidly change, and organizational responses must also be rapid. More frequent updates would allow hospitals to adjust staffing patterns, cooling strategies, and alert levels for at-risk patients as conditions evolve throughout the day.

Regarding communication channels, email emerged as the top platform for receiving forecast information. Weather apps on mobile devices, typically the standard pre-installed applications and local news apps, were commonly used, along with social media platforms, such as Facebook. Interestingly, while many public health and emergency stakeholders might use social media to broadcast messages to the public, they themselves rely heavily on email and official apps for receiving timely, detailed updates. This suggests that while public messaging strategies might focus on social media, internal professional communication networks might function differently. Tailoring the mode and frequency of communication can help ensure that the right people receive the right information at the right time.

Discussion

The survey findings from the public health preparedness coalition in Columbia, SC, USA, illustrate the complexity and importance of effective severe weather communication in the context of extreme heat. Infrastructure communication during severe weather is not solely about

physical systems, but also about how information flows to stakeholders who can intervene or mitigate harm. One of the key insights is that healthcare professionals currently rely on easily understandable heat metrics, but that these may not fully reflect actual physiological risk. As climate change intensifies heat events, relying on a single measure like temperature or even the heat index may inadequately represent the cumulative heat stress on underserved and vulnerable populations. Introducing the WBGT or a similar metric could provide a more accurate assessment, but only if these stakeholders understand and trust it (Sutton et al., 2023). Communication, therefore, must include educational components that clarify why these more sophisticated metrics matter and how to interpret them.

Another critical lesson is that information must move beyond strictly meteorological data. The coalition members expressed a clear desire for forecasts to come paired with actionable advice—location of cooling stations, frequency of updates, and details about community resources. This aligns closely with the concept of "impact-based decision support services" (IDSS), a paradigm within the NWS that emphasizes translating forecast data into concrete guidance for decision-making (National Weather Service, 2024b). Impact-based communication does not merely state a risk level; it should answer the question: "*What should I do?*" For these healthcare professionals, this might translate into instructions for scheduling cooling breaks for staff working outdoors, identifying high-risk patient groups who need proactive outreach, or advising patients' caregivers and loved ones on warning signs of heat-related illnesses (Edgerly, 2024).

Accessibility and clarity in communication also emerged as priorities. The feedback on the advisory graphic highlights that even when a majority understand the general message, there are still improvements to be made to increase accessibility and shareability. Adjusting the visual

framing, simplifying language, incorporating translations into multiple languages, and adding descriptive text (commonly known as 'alt text') for images ensures that all audiences, including those less familiar with local geography, non-native speakers, or individuals with visual impairments, can benefit from the forecast materials (Raja & Narasimhan, 2013). Improving communication channels, integrating community resource information, and offering multilingual messaging or culturally relevant examples can help ensure proper representation. Our findings suggest that infrastructure communication should be co-designed with input from local stakeholders, like healthcare providers who interact closely with at-risk populations.

The timing and frequency of updates also matter significantly. Extreme heat conditions can evolve quickly, and providing frequent, concise updates enables professionals to respond dynamically. However, infrequent updates or delayed communication can erode trust, particularly when new or conflicting information emerges. Regular and transparent updates not only equip healthcare professionals to share timely advice for reducing heat-related morbidity and mortality but also foster confidence in the reliability of forecasting agencies. As extreme weather becomes more frequent, agencies may need to invest in digital tools and platforms that can automatically disseminate updated forecasts and guidance at shorter intervals.

Finally, these exploratory results point to the importance of choosing appropriate communication channels, which may vary by population or age group. While public health agencies might distribute information widely through social media, older professionals or those in leadership roles may rely more heavily on email and specialized apps, whereas younger audiences or the general public might engage more frequently with social media platforms. Forecasters and emergency managers must recognize that one-size-fits-all communication strategies may fall short. Instead, a combination of email alerts for professionals, social media

advisories for the public (especially younger demographics), and detailed bulletins posted on institutional websites could help ensure broad coverage and meet the needs of diverse audiences.

Recommendations for Improving Heat-Health Communication

Based on our exploratory findings, we propose several strategies to enhance communication about extreme heat and the resulting infrastructure challenges:

1. **Introduce and Explain Advanced Metrics (e.g., WBGT):** Develop educational materials, webinars, or in-person training sessions for healthcare and emergency management professionals to understand WBGT. Provide simple scenarios comparing basic temperature/heat index values against WBGT estimates to illustrate why WBGT is more accurate in predicting heat stress risks.
2. **Impact-Based Messaging:** Integrate actionable guidance into weather forecasts. For example, pair the forecasted WBGT level with recommended actions: "*With today's WBGT above 90, advise patients without home air conditioning to seek cooling stations*," or "*Staff working outdoors should rest in the shade every 20 minutes*" or for those with concerns about energy costs, "*Cool foot baths reduce heat stress*." By moving from abstract numbers to practical steps, communicators can foster more effective responses.
3. **Local Contextualization**: Include information on the status and availability of local infrastructure resources—community cooling centers, outreach programs for older adults, and emergency medical services. Tailoring forecasts to specific neighborhoods, particularly those identified as HUSVCs, can help direct limited resources where they are most needed.
4. **Accessibility and Visual Enhancements**: Redesign graphics and advisories with user-friendly elements, plain language, and intuitive symbols (see Chapter X in this Handbook

for more advice on communicating effectively). Ensure all digital materials include alt text for visual elements and consider alternative formats for those with disabilities. Regularly solicit feedback from users to refine the presentation of information.

5. **Frequent and Flexible Updates**: Given the preference for updates as often as every four hours, consider providing more frequent bulletins during periods of extreme heat. These updates can be brief; short reminders with key metrics and actions can be enough to maintain situational awareness.
6. **Platform Diversity**: Since email is the preferred channel among these professionals, maintain email listservs for quick dissemination of updates. Simultaneously, leverage weather and news apps for real-time push notifications, and use social media platforms to reach broader audiences. Flexibility in communication ensures that urgent messages can reach recipients through their preferred channels.
7. **Cultural and Linguistic Relevance**: As many communities in the U.S. are multilingual and culturally diverse, consider providing advisories in multiple languages and using culturally relevant metaphors or references to help people understand risks. Partnering with community-based organizations can help tailor messaging to specific local contexts.

Conclusion

As infrastructure systems face increasing strain from severe weather events, the ability to communicate effectively about risks, response actions, and available resources becomes a linchpin of resilience. The Columbia, SC public health coalition's insights offer an example of the broader challenges and opportunities in this domain. Healthcare providers, emergency managers, and public health agencies operate at the interface between forecast data and community well-being. Their feedback underscores the need for communication that is not only

timely and accurate but also actionable, contextualized, and accessible. This helps ensure that vulnerable and underserved populations receive the support they need and that healthcare systems remain functional and prepared under extreme heat conditions.

This chapter has highlighted that for public safety to improve during extreme heat events, it is imperative to see communication about infrastructure conditions and severe weather forecasts as interdependent with social equity and health outcomes. In so doing, we acknowledge that the conversations initiated here are ongoing. Further research, stakeholder engagement, and iterative design of communication products will be necessary. We hope that through this process, we can help communities navigate a hotter future with greater resilience and less harm.

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