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UNDERSTANDING DECISION CONTEXT TO IMPROVE HEAT HEALTH INFORMATION

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The National Integrated Heat Health Information System (NIHHIS) Northeast Decision Calendar Workshop convened 42 heat-health decision-makers from public health, athletics, city and regional planning, elderly affairs, climate, meteorology, emergency management, energy, and decision science disciplines. The workshop sought to advance understanding of the information needs of this community by better characterizing the context of these needs—considering local climate, policy, culture, socioeconomics, and other factors. Participants

NIHHIS NORTHEAST DECISION CALENDAR WORKSHOP

WHAT: The National Integrated Heat Health Information System (NIHHIS) convened a regional workshop to understand the multidisciplinary user contexts for heat-health information, employing a decision calendar approach to document discipline-specific and time-scale-explicit decisions made to reduce heat-health risk.

WHEN: 18 October 2018

WHERE: Westborough, Massachusetts

AFFILIATIONS: JONES—National Oceanic and Atmospheric Administration, Silver Spring, Maryland, and University Corporation for Atmospheric Research, Boulder, Colorado; MECRAY—NOAA/NESDIS/National Centers for Environmental Information, Norton, Massachusetts; BIRKEL—Climate Change Institute, University of Maine, Orono, Maine; CONLON—University of California, Davis, Davis, California; KINNEY—School of Public Health, Boston University, Boston, Massachusetts; SILVA—NOAA/NWS/Climate Services Program, Silver Spring, Maryland; SOLECKI—Hunter College of the City University of New York, New York, New York; SURGEON ROGERS—Waquoit Bay National Estuarine Research Reserve, Falmouth, Massachusetts
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discussed their roles in managing heat-health risks in order to explore where they have had successes, where they have met challenges, and where opportunities exist to improve risk reduction efforts. The workshop and its work products are part of the National Integrated Heat Health Information System, which was jointly launched by the National Oceanic and Atmospheric Administration (NOAA) and the Centers for Disease Control and Prevention (CDC) to improve heat-health risk reduction efforts through improved understanding of risk and application of information by decision-makers. Developing this information requires a persistent investment in relationships with the user community across many disciplines. However, integrating information across disciplines and time scales, each with its own terms of art and frames of reference, can be very challenging. To address this challenge, we employed in this workshop the concept of decision calendars, detailed in the next section, to elicit this information in a structured way.

This workshop sought the following outcomes:

- Build and strengthen the network between a multidisciplinary set of heat-health decision-makers through relationship and awareness building.
- Identify and document locally contextualized interventions at the planning and preparedness time scales, with important constraints and considerations noted.
- Discipline-specific decision-makers will use planning scenarios to explore decision contexts behind the identified interventions, and specific information needs will be documented to support decisions in the form of decision calendars.

To achieve these outcomes, we convened an interdisciplinary planning team with strong local–regional ties to design a highly interactive workshop that allowed for discussions and critical thinking. After morning introductions and background, the meeting cycled through three sets of presentations and breakouts. Each set began with four or fewer “priming” talks to introduce heat-health risk management from a particular disciplinary perspective. This was followed by a small-group breakout session to develop concept maps tracing the path from health outcome through actions to mitigate risk, decision points, and information needed to inform decisions. Each cycle of this process included fewer presentations and more time for small group discussion. Breakouts gradually moved from open-concept maps to structured decision calendars by layering in consideration of time scales, decision authorities, information requirements, and assumptions.

DECISION CALENDARS ORGANIZE USER CONTEXT INFORMATION. Decision calendars are a framework for organizing information about user context in decision-making, initially applied to understanding water resource management decisions (Pulwarty and Sivakumar 2014; Ray and Webb 2016). They document what needs to be known when, by whom, and with what certainty in order to take actions to reduce heat-health risk. Decision calendars support development of climate and health information and services that are useful and usable. This workshop represents the first attempt to apply the decision calendar approach to heat hazards and associated human health impacts.

An example of a heat-health decision calendar is shown in Fig. 1. Though labeled a “calendar,” this approach is flexible enough to accommodate any time-explicit representation of a decision process.

In the NIHHS Northeast workshop, we chose to organize decision points on a modified timeline that begins on the right with an active heat wave but progresses backward through larger time steps by adding additional lead time to the left. The central tracks represent a stream of decision points identified to be the responsibility of a particular decision-maker—in this case an emergency manager and an urban planner. Interactions between decision-makers across these tracks are not only possible, but essential to identify and represent explicitly. The bottom section identifies information needs and questions that must be answered in support of the decisions identified above them.

Importantly, this first phase does not directly track to operational or research “requirements.” It is rare for a decision-maker in another field to be able to clearly state their precise climate and weather information needs in terms of research and operational requirements. Instead, the decision calendar is a tool for iteratively elucidating these requirements by starting from the user’s context and working back toward requirements. Subsequent activities are being planned in the Northeast to develop decision scenario exercises and active prototyping sessions where we can work with novel integrated information sets together with decision-makers and other subject matter experts.

THE NEED FOR NIHHS. Extreme heat can have disastrous impacts on human health. Human exposure to high temperatures, exacerbated by other meteorological factors including increased humidity, solar exposure, and low ventilation, can induce acute health effects ranging from nausea, headaches, and muscle cramps to acute organ failure and death (Hosokawa 2018). It can also trigger irreversible long-term diseases such as chronic kidney disease, which has been observed in occupational settings across the world (Glaser et al. 2016). Global-mean temperature is increasing (USGCRP 2017) and, as it does, extreme heat and its health effects—as well as impacts on health-sustaining infrastructure such as electrical grids and hospital systems—will most likely increase as well if human exposure and vulnerability is not managed.

Owing to these risks, CDC and NOAA launched NIHHS to better understand how decision-makers in many disciplines—and on many time scales—protect vulnerable people from heat; what information they need to make risk-reducing decisions; and where federal health, environmental intelligence, disaster risk management, and other agencies can invest in

NIHHIS Decision Calendar Prototype

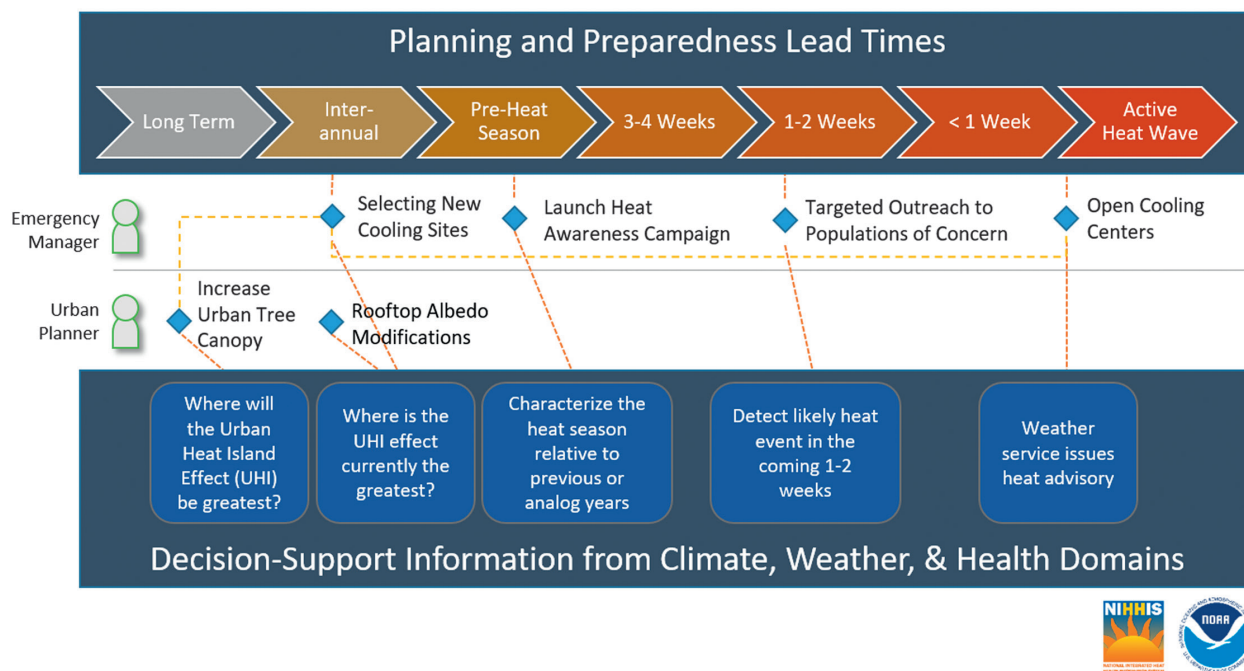


FIG. 1. A prototype decision calendar documenting the decisions made by emergency managers and urban planners to manage the urban heat island effect at all time scales, as well as information needs to support their decisions.

research and information services to support long-term heat-health risk reduction.

From inception, NIHHIS quickly expanded to include additional agency representation from the Federal Emergency Management Agency (FEMA), U.S. Department of Agriculture (USDA), Environmental Protection Agency (EPA), Occupational Safety and Health Administration (OSHA), National Institute for Occupational Safety and Health (NIOSH), Substance Abuse and Mental Health Services Administration (SAMHSA), and the Assistant Secretary for Preparedness and Response (ASPR). These agencies compiled resources and launched a heat-health information portal (<https://climate.gov/nihhis>) for unified access to heat-health-relevant information such as information on vulnerable populations and weather and climate predictions.

NIHHIS has hosted pilot projects in communities across the United States to build awareness of heat-health risks, to enrich the existing network of practitioners working to address these risks, and to define and document the local context of extreme heat to understand how decisions could be better supported by information and services from climate, weather, health, and other sectors. The first pilot project took place along the southern border, integrating the heat-health communities in El Paso,

Texas; Las Cruces, New Mexico; and Ciudad Juárez, Mexico. Since its first workshop in July 2016 (Garfin et al. 2017a), this pilot has become self-sustaining and works to implement many of the identified risk reduction opportunities (Garfin et al. 2017b), such as training Latina community health workers to better utilize weather and climate information to protect vulnerable populations living on the outskirts of town. This latest workshop, held in Massachusetts, serves to formally launch a new NIHHIS pilot project in the Northeast.

NIHHIS NORTHEAST WORKSHOP OUTCOMES.

Though all of the attendees of this meeting were practitioners who contributed to the management of heat-health risk in the Northeast, many of them had never met in person. Some had not considered the role of many of the disciplines present in managing heat. Others were well on their way to improving the response to heat but were eager to learn what more they could do by way of preparedness and planning: what heat risk reduction actions they could introduce weeks to decades in advance of a heat wave.

This workshop began the process of developing decision calendars. Subsequent engagements in the Northeast and with other NIHHIS regions will continue to develop these work products and will

document understanding of information needs and use contexts with the aim of informing research and operational requirements in many disciplines. However, many insights from the meeting's discussions are immediately useful:

- The athletics, military, and occupational health communities use wet-bulb-globe temperature (WBGT) to estimate risk to their populations because it better captures the experienced environmental temperature than simpler approaches (Hosokawa et al. 2019). Onsite WBGT measurement is often considered the gold standard, and improvements to WBGT prediction at finer spatial scales—downscaling to an athletic field or a work site—can support early warning and advanced mitigative action to prevent exertional heat illness.
- One factor reducing reliability of electricity during heat events is that power lines expand and sag, sometimes becoming entangled in trees and ultimately resulting in downed lines and power outages. This must be considered when siting urban greening actions such as tree plantings.
- The Low Income Home Energy Assistance Program (LIHEAP) subsidizes energy costs for cooling and heating, but in the Northeast this money tends to be allocated to winter heating and little to no reserves are held for use in summer cooling. Improved seasonal to annual predictions could support better budgeting decisions for programs such as LIHEAP.
- Boston has an initiative called Seniors Save that allows seniors to apply for home improvement grants, but the program does not yet explicitly include improvements for summer cooling. Subsidized or free energy efficiency and home retrofit programs may help residents stay cool in the summer and warm in the winter, but many homes in New England are disqualified from receiving these benefits because they were built with older techniques and technologies and would be too costly to retrofit. Looking forward, a new building standard could be created requiring that builders of new homes consider climate predictions to ensure buildings can reliably sustain safe temperatures for their occupants.
- Urban heat island (UHI) mapping techniques, when combined with census-block-level socioeconomic data and other measures of vulnerability and exposure, can support prioritization of UHI reducing actions. However, many UHI techniques use unverified satellite estimates of land surface

temperature, missing many other factors that influence actual experienced temperatures.

- Heat early warning systems (HEWS) and heat action plans (HAPs) are useful and are used in many cities and states in the Northeast. Opportunities exist to improve these tools by implementing a multitiered early warning approach that incorporates longer-term probabilistic information and also by varying alert content, medium, and lead time by vulnerable population. For example, Boston currently uses magazine inserts and robocalls to reach its elderly population in advance of a heat wave but also dispatches neighborhood advocates who can help at-risk individuals find their nearest cooling center.
- The use of existing media and communication channels as well as existing programs and policies is a recurring theme. New Hampshire reaches its elderly population through Meals on Wheels to deliver information and check on this population.
- NOAA's National Weather Service offices in the Northeast recently worked with public health and emergency management professionals, including the Northeast Regional Heat Collaborative, to revise heat-alert thresholds to a lower level based upon newly available evidence and observations available from satellites, land-based stations, and the National Environmental Public Health Tracking Network. Recurring reassessments of heat-alert thresholds and the effectiveness of HAPs and HEWs are an important step to keep them tuned to protect vulnerable populations and should be done after every major event as well as every 5–10 years as local risk factors may change.
- Awareness of heat risk is still an issue: within vulnerable populations and those who work to protect them. Several participants found that making heat morbidity and mortality information more available, more accurate, more understandable, and timelier—such as through interactive mapping tools and web-based or social media-ready graphics—could help address this.

These workshop findings will continue to be refined through repeated engagements with the decision-makers in the Northeast through a variety of NIHHS channels such as the NIHHS portal, webinars, tabletop and scenario planning exercises, focus groups, presentation in existing meetings, and prototyping of new information tools. As decision calendars are assembled based on these conversations in the Northeast, they will be exposed to the rest of the NIHHS network, including pilots in the Southeast/Mid-Atlantic and

the Southwest to test them for robustness and to identify location-specific considerations that should be included in the decision calendars.

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