Defining Disaster: Incorporating Heat Waves and Smoke Waves into Disaster Policy

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Summary

Extreme heat – and similar people-centered disasters like heavy wildfire smoke – kills thousands of Americans annually, more than any other weather disaster. However, U.S. disaster policy is more equipped for events that damage infrastructure than those that mainly cause deaths. Policy actions can save lives and money by better integrating people-centered disasters.

Challenge and Opportunity

At the federal level, emergency management is coordinated through the Federal Emergency Management Agency (FEMA), with many other agencies as partners, including Centers for Disease Control (CDC), Department of Housing and Urban Development (HUD), and Small Business Administration (SBA). Central to the FEMA process is the requirement under the Stafford Act that the President declare a major disaster, which has never happened for extreme heat. This seems to be caused by a lack of tools to determine when a heat wave event escalates into a heat wave disaster, as well as a lack of a clear vision of federal responsibilities around a heat wave disaster.

Gap #1: When is a heat event a heat disaster?

A core tenet of emergency management is that events escalate into disasters when the impacts exceed available resources. Impact measurement is increasingly quantitative across FEMA programs, including quantitative metrics used in awarding Fire Management Assistance Grant (FMAG), Public Assistance (PA), and Individual Assistance (IA) and in the Benefit Cost Analysis (BCA) for hazard mitigation grants.

However, existing calculations are unable to incorporate the health impacts that are a main impact of heat waves. When health impacts are included in a calculation, it is only in limited cases; for example, the BCA allows mental healthcare savings, but only for residential mitigation projects that reduce post-disaster displacement.

Gap #2: What is the federal government's role in a heat disaster?

Separate from the declaration of a major disaster is the federal government's role during that disaster. Existing programs within FEMA and its partner agencies are designed for historic disasters rather than those of the modern and future eras. For example, the National Risk Index (NRI), used to understand the national distribution of risks and vulnerability, bases its risk assessment on events between 1996 and 2019. As part of considering future disasters, disaster policy should consider intensified extreme events and compound hazards (e.g., wildfire during a heat wave) that are more likely in the future.

A key part of including extreme heat and other people-centered disasters will be to shift toward future-oriented resilience and adaptation. FEMA has already been making this shift, including a reorganization to highlight resilience. The below plan of action will further help FEMA with its mission to help people before, during, and after disasters.

Plan of Action

To address these gaps and better incorporate extreme heat and people-centered disasters into U.S. emergency management, Congress and federal agencies should take several interrelated actions.

Part 1: Defining disaster

To clarify that extreme heat and other people-centered disasters can be disasters, Congress should:

1. Add heat, wildfire smoke, and compound events (e.g., wildfire during a heat wave) to the list of disasters in Section 102(2) of the Stafford Act. Though the list is intended to be illustrative rather than exhaustive, as demonstrated by the declaration of COVID-19 as a disaster despite not being on the list, explicit inclusion of these other disasters on the list clarifies that intent. This action is widely supported and example legislation includes the Extreme Heat Emergency Act of 2023.
2. FEMA should standardize procedures for determining when disparate eventsare actually a single compound event. For example, many individual tornadoes in Kentucky in 2021 were determined to be the results of a single weather pattern, so the event was declared as a disaster, but wildfires that started due to a single heat dome in 2022 were determined to be individual events and therefore unable to receive a disaster declaration. Compound hazards are expected to be more common in the future, so it is critical to work toward standardized definitions.
3. Add a new definition of "damage" to Section 102 of the Stafford Act that includes human impacts such as death, illness, economic impacts, and loss of critical function (i.e., delivery of healthcare, school operations, etc.). Including this definition in the statute facilitates the inclusion of these categories of impact.

To quantify the impacts of heat waves, thereby facilitating disaster decisions, FEMA should adopt strategies already used by the federal government. In particular, FEMA should:

4. Work with HHS to expand the capabilities of the National Syndromic Surveillance Program (NSSP) to evaluate in real time various societal impacts like the medical-care usage and work or school days lost. Recent studies indicate that lost work productivity is a major impact of extreme heat that is currently unaccounted—a gap of potentially billions of dollars. The NSSP Community of Practice can help expandtools across multiple jurisdictions too. Expanding syndromic surveillance expands our ability to measure the impacts of heat, building on the tools available through the CDC Heat and Health Tracker.
5. Work with CDC to expand their use of excess-death and flu-burden methods, which can provide official estimates of the health impacts of extreme heat. These methods are already in use for heat, but should be regularly applied at the federal level, and would complement the data available from health records via NSSP because it calculates missing data.

6. Work with EPA to expand BenMAP software to include official estimates of health impacts attributable to extreme heat. The current software provides official estimates of health impacts attributable to air pollution and is used widely in policy. Research is needed to develop health-impact functions for extreme heat, which could be solicited in a research call such as through NIH's Climate and Health initiative, conducted by CDC epidemiologists, added to the Learning Agenda for FEMA or a partner agency, or tasked to a national lab. Additional software development is also needed to cover real-time and forecast impacts in addition to the historic impacts it currently covers. The proposed tool complements Recommendations #4-5 because it includes forecast data.
7. Quantify heat illness and death impacts. Real-time data is available in the CDC Heat and Health Tracker. These impacts can be converted to dollars for comparison to property damage using the Value of a Statistical Life (VSL), which FEMA already does in the NRI ($11.6 million per death and $1.16 million per injury in 2022). VSL should be expanded across FEMA programs, in particular the decision for major disaster declarations. VSL could be immediately applied to current data from NSSP, to expanded NSSP and excess-death data (Recommendations #4-5), and is already incorporated into BenMAP so would be available in the expanded BenMAP (Recommendation #6).
8. Quantify the impact of extreme heat on critical infrastructure, including agriculture. Improved quantification methods could be achieved by expanding the valuation methods for infrastructure damage already in the NRI and could be integrated with the National Integrated Heat Health Information System (NIHHIS). The damage and degradation of infrastructure is often underestimated and should be accurately quantified. For example,
    a. he Federal Highway Administration (FHWA) has reported on extreme heat and documented heat impacts on asset management, where the Department of Transportation (DOT) in multiple states, including Arizona's DOT, and the National Cooperative Highway Research Program have developed evaluation methods for quantifying impacts, and
    b. impacts to critical infrastructure have been quantified across sectors and should include representative agencies such as transportation (e.g., FHWA, DOT), transit (e.g., Federal Transit Authority (FTA)), energy (e.g., Department of Energy (DOE), EPA, water/sanitation (e.g., U.S. Army Corps of Engineers (USACE), Bureau of Reclamation (BOR)), telecommunications (e.g., Department of Homeland Security, Federal Communications Commission), social (e.g., HUD, HHS, Department of Education (ED)), and environmental infrastructures (e.g., EPA, USACE, National Parks Service (NPS)).

Together, these proposed data tools would provide FEMA with a comprehensive understanding of the impacts of extreme heat on human health in the past, present, and near future, putting heat on the same playing field as other disasters.

Real-time impacts are particularly important for FEMA to investigate requests for a major disaster declaration. Forecast impacts are important for the ability to preposition resources, as currently done for hurricanes. The goal for forecasting should be 72 hours. To achieve this goal from current models (e.g., air quality forecasts are generally just one day in advance):

9. Congress should fund additional sensors for extreme weather disasters, to be installed by the appropriate agencies. More detailed ideas can be found in other FAS memos for

extreme heat and wildfire smoke and in recommendation 44 of the recent Wildland Fire Commission report.

10. Congress should invest in research on integrated wildfire-meteorological models through research centers of excellence funded by national agencies or national labs. Federal agencies can also post specific questions as part of their learningagendas. Models should specifically record the contribution of wildfire smoke from each landscape parcel to overall air pollution in order to document the contribution of impacts. This recommendation aligns with the Fire Environment Center proposed in the Wildland Fire Commission report.

Table 1. Division of proposed improvements by time period addressed and implementation readiness

	Historic	Real time	Forecast
Integrate existing capabilities with FEMA	Excess death methods (#5)	Use VSL (#7)	
Expand program abilities		Expand infrastructure calculations, NSSP, BenMAP, and sensors (#4–9)	Expand BenMAP (#6) and improve smoke forecasts (#10)
Cross-cutting definitions	Stafford Act amendments (#1, 3) and compound events (#2)		

Part 2: Determining federal response to heat disasters

To incorporate extreme heat and people-centered disasters across emergency management, FEMA and its peer agencies can expand existing programs into new versions that incorporate such disasters. We split these programs here by the phase of emergency management.

Preparedness:

11. Using Flood Maps as a model, FEMA should create maps for extreme heat and other people-centered disasters. Like flood maps, these new maps should highlight the infrastructure at risk of failure or the loss of access to critical infrastructure (e.g., FEMA Community Lifelines) during a disaster. Failure here is defined as the inability of infrastructure to provide its critical function(s); infrastructure that ceases to be usable for its purpose when an extreme weather event occurs (i.e., bitumen softening on airport tarmacs, train line buckling, or schools canceled because classrooms were too hot or too smokey). This includes impacts to evacuation routes and critical infrastructure that would severely impact the functioning of society. Creating such a map requires a major interagency effort integrating detailed information on buildings, heat forecasts, energy grid capacity, and local heat island maps, which likely requires major interagency collaboration. NIHHIS has most of the interagency collaborators needed for such effort, but should also include the Department of Education. Such an effort likely will need direct funding from Congress in order to have the level of effort needed.

12. FEMA and its partners should publish catastrophic location-specific scenarios to align preparedness planning. Examples include the ARkStorm for atmospheric rivers, HayWired for earthquake, and Cascadia Rising for tsunami. Such scenarios are useful because they help raise public awareness and increase and align practitioner preparedness. A key part of a heat scenario should be infrastructure failure and its cascading impacts; for example, grid failure and the resulting impact on healthcare is expected to have devastating effects.
13. FEMA should incorporate future projections of disasters into the NRI. The NRI currently only uses historic data on losses (typically 1996 to 2019). An example framework is the $100 million Prepare California program, which combined historic and projected risks in allocating preparedness funds. An example of the type of data needed for extreme heat includes the changes in extreme events that are part of the New York State Climate Impacts Assessment.
14. FEMA should expand its Community Lifelines to incorporate extreme heat and cascading impacts for critical infrastructure as a result of extreme heat, which must remain operable during and after a disaster to avoid significant loss of human life and property.
15. The strategic national stockpile (SNS) should be expanded to focus on tools that are most useful in extreme weather disasters. A key consideration will be fluids, including intravenous (IV) fluids, which the current medical-focused SNS excludes due to weight. In fact, the SNS relies on the presence of IV fluids at the impacted location, so if there is a shortage due to extreme heat, additional medicines might not be deliverable. To include fluids, a new model will be necessary because of the logistics of great weight.
16. OSHA should develop occupational safety guidelines to protect workers and students from hazardous exposures, expanding on its outdoor and indoor heat-related hazards directive. Establishing these thresholds, such as max indoor air temperatures similar to California's Occupational Safety and Health Standards Board, can help define the threshold of when a weather event escalates into a disaster. No federal regulations exist for air quality, so California's example could be used as a template. The need already exists: an average of 2,700 heat-related injuries and 38 heat-related fatalities were reported annually to OSHA between 2011 and 2019.
17. FEMA and its partners should expand support for community-led multi-hazard resilience hubs, including learning from those focused on extreme heat. FEMA already has its Hubs for Equitable Resilience and Engagement, and EPA has major funding available to support resilience hubs. This equitable model of disaster resilience that centers on the needs of the specific community should be supported.

Response

18. FEMA should introduce smaller disaster-assistance grants for extreme weather disasters: HMAG, CMAG, and SMAG (Heat, Cold, and Smoke Management Assistance Grants, respectively). They should be modeled on FMAG grants, which are rapidly awarded when firefighting costs exceed available resources but do not necessarily escalate to the level of a major disaster declaration. For extreme weather disasters, the model would be similar, but the eligible activities might focus on climate-controlled shelters, outreach teams to reach especially vulnerable populations, or a surge in medical personnel and equipment. Just like firefighting equipment and staff needed to fight wildfires, this equipment and staff are needed to reduce the impacts of the disaster. FMAG is supported by the Disaster Relief Fund, so if the H/C/SMAG programs also tap that, it

will require additional appropriations. Shelters are already supported by the Public Assistance (PA) program, but PA requires a major disaster declaration, so the introduction of lower-threshold funds would increase access.

19. HHS could activate Disaster Medical Assistance Teams to mitigate any surge in medical needs. These teams are intended to provide a surge in medical support during a disaster and are deployed in other disasters. See our other memos on this topic.
20. FEMA could deploy Incident Management Assistance Teams and supporting gear for additional logistics. They can also deploy backup energy resources such as generators to prevent energy failure at critical infrastructure.

Recovery and mitigation:

21. Programs addressing gray or green infrastructure should consider the impact upgrades will have on heat mitigation. For example, EPA and DOE programs funding upgrades to school gray infrastructure should explicitly consider whether proposed upgrades will meet the heat mitigation needs based on climate projections. Projects funding schoolyard redesign should explicitly consider heat when planning blacktop, playground, and greenspace placement to avoid accidentally creating hot spots where children play. CAL FIRE's grant to provide $47 million for schools to convert asphalt to green space is a state-level example.
22. Expand the eligible actions of FEMA's Hazard Mitigation Assistance (HMA) to include installation/upgrade of heating, ventilation, and cooling (HVAC) systems and a more expansive program to support nature-based solutions (NBS) like green space installation. Existing guidance allows HVAC mitigation for other hazards and incentivizes NBS for other hazards.
23. Increase alignment across federal programs, identifying programs where goals align. For example, FEMA just announced that solar panels would be eligible for the 75% federal cost share as part of mitigation programs; other climate and weatherization improvements should also be eligible under HMA funds.
24. FEMA should modify its Benefit Cost Analysis (BCA) process to fairly evaluate mitigation of health and life-safety hazards, to better account for mitigation of multiple hazards, and to address equity considerations introduced in Office of Management and Budget's recent BCA proposal. Some research is likely needed (e.g., the cost-effectiveness of various nature-based solutions like green space is not yet well-defined enough to use in a BCA); this research could be performed by national labs, put into FEMA's Learning Agenda, or tasked to a partner agency like DOE.
25. Expand the definition of medical devices to include items that protect against extreme weather. For example, the Center for Medicare and Medicaid Services could define air-conditioning units and innovative personal cooling devices as eligible for prescription under Medicare/Medicaid.

To support the above recommendations, Congress should:

26. Ensure FEMA is sufficiently and consistently funded to conduct resilience and adaptation activities. Congress augments the Disaster Relief Fund in response to disasters, but they report that the fund will be billions of dollars in deficit by September 2024. It has furthermore been reported that FEMA has delayed payments due to uncertainty of funding through Congressional budget negotiations. In order to support the above programs, it is essential that Congress fund FEMA at a level needed to act. To support FEMA's shift to a focus on resilience, the increase in funding should be

through annual appropriations rather than the Disaster Relief Fund, which is augmented on an ad hoc basis.

27. Convene a congressional commission like the recent Wildland Fire Commission to analyze the federal capabilities around extreme weather disasters and/or extreme heat. This commission would help source additional ideas and identify political pathways toward creating these solutions, and is merited by the magnitude of the disaster.

Conclusion

People across the U.S. are being increasingly exposed to extreme heat and other people-centered disasters. The suggested policies and programs are needed to upgrade national emergency management for the modern and future era, thereby saving lives and reducing disaster costs to the public.

FAQs

Are the impacts of extreme heat and other people-centered disasters significant enough to be considered disasters?

We estimate a minimum of **1,670 deaths and $157.8 billion of annual heat impacts**. These deaths and dollar amounts exceed almost every recorded disaster in U.S. history. Only COVID-19, 9/11, and Hurricanes Maria and Katrina have more deaths, and only Hurricanes Katrina and Harvey have caused more dollar damage. It should be noted that most of the estimates reported are several years out of date and exclude major heat waves of 2021 and 2022. For example, individual heat waves produced sizable numbers of deaths, including 395 deaths in a 2022 California heat wave and 600 deaths in the 2021 Pacific Northwest heatwave.

Health ($20 billion)

The CDC's 2022 Mortality Statistics estimates 1,670 deaths annually are attributable to extreme heat. Using FEMA's estimate of the Value of a Statistical Life ($11.6 million 2022 USD), that is $19.4 billion. Additional costs come from the burden on the healthcare system, which is estimated at $1 billion annually.

Infrastructure ($1–16 billion)

The impacts of extreme heat are estimated at $1 billion in 2020 and are projected to impose a cost burden of approximately $26 billion on the U.S. transportation sector by the year 2040. Agriculture loses billions of dollars each year from natural hazards. Drought, made worse by high heat conditions, accounts for a significant amount of the losses. In 2023, 80% of emergency disaster designations declared by the United States Department of Agriculture (USDA) were for drought or excessive heat. In 2023, the Southern/Midwestern drought and heatwave was the costliest disaster, at $14.5 billion in losses.

Workforce ($136.8 billion annually)

Between 2011 and 2019, an average of 2,700 heat-related injuries and 38 heat-related fatalities were reported annually to OSHA ($36.8 billion annually using the VSL). Lost work productivity is a major impact of extreme heat that is currently unaccounted for, but was estimated at $100 billion for 2020 and is projected to reach $500 billion by 2050.

Other people-centered disasters

There are an estimated 6,000 annual acute and chronic deaths due to wildfire smoke (spanning 2006–2018) and 1,300 deaths attributable to extreme cold (estimates prior to 2010). These health impacts are comparable to those of extreme heat, and again even these high impacts exclude recent smoke waves of 2020, 2021, and 2023 and cold waves of 2021 and 2022.

How could the Stafford Act be amended to include heat waves?

It is insufficient to just add heat to the list of disasters enumerated in the Stafford Act because it omits (1) the important recognition of compound events that often are associated with extreme heat, (2) other people-centered disasters like smoke waves, and (3) the ability to measure these disasters. We, therefore, recommend some version of the following text:

Section 102(2) of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5122(2)) is amended by striking "or drought" and inserting "drought, heat, smoke, or any other weather pattern causing a combination of the above".

Section 102 of the Robert T. Stafford Disaster Relief and Emergency Assistance Act (42 U.S.C. 5122(2)) is amended by inserting

(13) DAMAGE—"Damage" means--

(A) Loss of life or health impacts requiring medical care

(B) Loss of property or impacts on property reducing its ability to function

(C) Diminished usable lifespan for infrastructure

(D) Economic damage, which includes the value of a statistical life, burden on the healthcare system due to injury, burden on the economy placed by lost days of work or school, agricultural losses, or any other economic damage that is directly measurable or calculated.

(E) Infrastructure failure of any duration, including temporary, that could lead to any of the above