COMMITTEE ON SCIENCE, SPACE, AND TECHNOLOGY
U.S. HOUSE OF REPRESENTATIVES
SUBCOMMITTEE ON ENVIRONMENT

HEARING CHARTER

Silent Killer: The Rising Problem of Extreme Heat in the U.S.

Wednesday, July 21, 2021
10:00 a.m. ET
2318 Rayburn House Office Building and Online via Zoom

PURPOSE

This hearing will provide an opportunity to discuss the state of our understanding of extreme heat events across the U.S., and will touch on urban heat islands, the role of climate change, and impacts to public health. The Subcommittee will also examine research gaps and additional Federal research, coordination, and monitoring needed to improve the U.S. response to extreme heat.

WITNESSES

- **Dr. Vivek Shandas, Ph.D.**, Professor, Nohad A. Toulan School of Urban Studies and Planning, Founder and Director, Sustaining Urban Places Research Lab, Portland State University
- **Dr. Melissa Guardaro, Ph.D.,** Assistant Research Professor, Healthy Urban Environments & Knowledge Exchange for Resilience, Global Institute of Sustainability and Innovation, Arizona State University
- **Mr. Shimon Elkabetz**, CEO, Co-Founder, Tomorrow.io
- **Dr. Aaron Bernstein, MD, MPH**, Interim Director, The Center for Climate, Health, and the Global Environment, Harvard T.H. Chan School of Public Health, Pediatrician, Boston Children's Hospital, Fellow, Adrienne Arsht - Rockefeller Foundation Resilience Center

OVERARCHING QUESTIONS

- What is the state of our ability to monitor, predict, and forecast extreme heat events in the U.S.? How does warming in urban areas compare to warming elsewhere?
- What additional resources or investments would improve our ability to forecast extreme heat events?
- What are the major research gaps related to extreme heat?
- How much worse is climate change making extreme heat events across the U.S.?

- What are the most vulnerable populations to extreme heat in the U.S. and what contributes to their vulnerability?
- What metrics do we have to monitor the effectiveness of interventions to extreme heat, such as cooling centers?
- How can we strengthen existing Federal agency and interagency (i.e. the National Integrated Heat Health Information System) capacity for addressing extreme heat?
- How can the Federal Government work more effectively with local and State governments and organizations to improve the preparedness and response of communities to extreme heat events?
- What are the elements of a successful early warning system for extreme heat?

BACKGROUND

Extreme Heat in the U.S.

Extreme heat is a global health threat, and in the U.S., it is deadlier than all other natural disasters combined.[1] Over the last few decades, unusually hot summer days and nights have become increasingly prevalent across the continental U.S.[2] The definition of extreme heat depends on different factors such as location, weather conditions, and time of year, but generally is described as weather that is significantly hotter than expected for a certain location during a particular season.[3] Other weather conditions, like increased humidity, also increase the heat index (how hot it feels),[4] making it feel hotter than it actually is.[5] For example, a May temperature of 92°F in Boston is extreme heat, whereas a May temperature in Phoenix would have to reach more than 100°F to be considered extreme.[6]

Heat waves – multi-day extreme heat events – are becoming more common in major cities across the U.S.[7] These events have increased from an average of two per year in the 1960s to more than six per year in the 2010s. Nearly 50 major cities have an average heat wave season 47 days longer than they did in the 1960s.[8] In fact, heat waves, extreme heat events, and record-breaking hot years are expected to grow in frequency.[9] For example, the Pacific Northwest has already experienced a record-breaking heat wave in 2021, termed a "heat dome." The cities of Portland, Seattle, and Salem all broke temperature records, reaching 116 °F, 108 °F, and 117 °F,

[1] Changes in land cover and terrestrial biogeochemistry. In Climate Science Special Report: Fourth National Climate Assessment.
[2] https://toolkit.climate.gov/topics/human-health/extreme-heat#footnote1_qst5cyw
[3] https://www.epa.gov/sites/production/files/2016-10/documents/extreme-heat-guidebook.pdf
[4] https://www.weather.gov/ama/heatindex
[5] https://www.cdc.gov/disasters/extremeheat/heat_guide.html
[6] https://www.epa.gov/sites/default/files/2016-10/documents/extreme-heat-guidebook.pdf
[7] https://www.epa.gov/climate-indicators/climate-change-indicators-heat-waves
[8] https://www.globalchange.gov/browse/indicators/us-heat-waves
[9] https://science2017.globalchange.gov/chapter/executive-summary/

respectively.[10] These temperatures congested roadways, melted power cables, and caused excess heat-related mortality.[11]

Urban Heat Island Effect

Urbanized areas, including big and small cities and suburban areas, tend to be warmer than surrounding rural areas because of the "urban heat island" effect.[12] Buildings, roads, and other infrastructure absorb and re-emit more heat from the sun than natural landscapes such as forested areas and bodies of water. Urban heat islands have higher daytime maximum temperatures and warmer nighttime temperature than surrounding areas, with daytime temperatures between 15°F to 20°F warmer during the day.[13] At night, the difference can be as high as 22°F because the built environment retains heat absorbed during the day.[14] Hotter nighttime temperatures pose serious health risks if people cannot recover from exposure to daytime heat. Research suggests that the effects of heat islands will be intensified in the future as urban areas grow in spatial extent and population density.[15]

Urban heat islands are often intensified in communities of color and low-income communities where they often have fewer trees and access to air conditioning, more concrete, and are closer to highways and factories. These disparities are the result of the legacy of historic redlining and discriminatory housing practices.[16] Additional information on the intersection of extreme heat, COVID-19, and environmental justice can be found in the charter from the July 14, 2020 Science Committee hearing titled "*Sweltering in Place: COVID-19, Extreme Heat, and Environmental Justice."* [17]

Since 2018, NOAA has supported community-led urban heat island mapping campaigns through partnerships with universities and environmental and social justice groups to study heat risk and local vulnerabilities, including race and ethnicity, air conditioning access, and heat-related illnesses.[18]

Societal Impacts of Extreme Heat

Heat is called a "silent killer" because it is an invisible threat. The Centers for Disease Control and Prevention (CDC) officially reports that extreme heat kills more than 600 Americans annually, but many heat-related deaths are underreported. Some reports estimate the number is

[10] https://www.nytimes.com/2021/06/27/us/heat-wave-seattle-portland.html
[11] https://www.vox.com/22538401/heat-wave-record-temperature-extreme-climate-change-drought
[12] https://qz.com/1952702/how-global-warming-is-changing-city-temperatures/
[13] https://nihhis.cpo.noaa.gov/Urban-Heat-Island-Mapping/Understand-Urban-Heat-Islands
[14] https://www.epa.gov/sites/default/files/2016-10/documents/extreme-heat-guidebook.pdf
[15] Changes in land cover and terrestrial biogeochemistry. In Climate Science Special Report: Fourth National Climate Assessment.
[16] https://www.tandfonline.com/doi/full/10.1080/01944363.2020.1759127
[17] https://science.house.gov/hearings/sweltering-in-place-covid-19-extreme-heat-and-environmental-justice
[18] https://nihhis.cpo.noaa.gov/Urban-Heat-Island-Mapping/UHI-Campaigns/Campaign-Cities

closer to 5,000[19] or 12,000.[20] Extreme heat is responsible for more than 65,000 emergency room visits each summer for acute heat illness.[21] Scientists predict that as extreme heat events become more common, severe, and long-lasting, there will be a rise in heat-related deaths and illnesses, especially among vulnerable populations such as children, the elderly, historically marginalized populations, and those with chronic health conditions.[22]

While some groups are more vulnerable to heat than others, everyone is affected by heat. Extreme heat stresses the body's ability to maintain a normal temperature and impacts can range from more mild heat cramps, to heat exhaustion, and finally heat stroke, which is the most serious heat-related illness.

Multiple sectors of the economy are vulnerable to extreme heat, especially agriculture and construction. Heatwaves cause reduced worker productivity, with an estimated two percent of total working hours projected to be lost globally each year by 2030.[23] High nighttime temperatures can also directly damage agriculture, as some crops require cooler nighttime temperatures.[24] Livestock may also experience increases in heat stress when they cannot cool down at night, causing milk supply to drop, growth to halt, and conception rates to drop.[25]

Higher summer temperatures increase demand for electricity for cooling which reduces the capacity of power transmission lines. This can possibly lead to problems with electricity dependability amid heat waves.[26]

Climate Change and Extreme Heat

Globally, average temperatures have risen 2.14˚F (1.19˚C) since the late 19th century due to burning of fossil fuels, with 2016 and 2020 tying as the hottest years on record.[27] Temperatures are expected to continue to rise through the end of this century. In the U.S., average temperatures have also risen, with some parts experiencing more warming than others, namely the North, West, and Alaska.[28]

In addition to overall warming, the U.S. is experiencing more heatwaves and extreme heat events. For example, the number of heatwaves has increased by 20 percent from 1945 to 1995.[29]

---

[19] https://www.medicinenet.com/script/main/art.asp?articlekey=238921
[20] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC7125937/
[21] https://www.nrdc.org/climate-change-and-health-extreme-heat#/map#fnf
[22] https://toolkit.climate.gov/topics/human-health/extreme-heat
[23] https://www.ilo.org/wcmsp5/groups/public/---dgreports/---dcomm/---publ/documents/publication/wcms_711919.pdf
[24] https://www.c2es.org/content/heat-waves-and-climate-change/.
[25] https://www.farms.com/news/at-what-temperature-the-weather-becomes-a-problem-169298.aspx
[26] https://www.vox.com/recode/2021/7/3/22560691/power-grid-climate-change-heat-wave
[27] https://www.nasa.gov/press-release/2020-tied-for-warmest-year-on-record-nasa-analysis-shows
[28] https://www.epa.gov/sites/default/files/2016-10/documents/extreme-heat-guidebook.pdf
[29] https://www.ajpmonline.org/article/S0749-3797(08)00686-7/fulltext

As global temperatures rise, soil dryness in surrounding areas often increases.[30] These soil dryness conditions can amplify extreme temperatures during heatwaves.[31] Without significant greenhouse gas emissions mitigation, the number of extremely hot days will grow by 75 percent through 2050, and triple from 2050 to 2100.[32] With 2°C of global warming, extreme heat events like those experienced in the Pacific Northwest during late June and early July of 2021 will increase in frequency from once every 1000 years to every 5 to 10 years.[33]

Extreme heat events amplified by climate change will also lead to more heat-related deaths. Under a "business as usual" emissions scenario, mortalities from extreme heat are projected to increase by as much as three times.[34] In 44 cities across the U.S., some projections predict excess mortality from extreme heat and heatwaves more than doubling through 2050.[35]

Federal Monitoring and Forecasting of Extreme Heat

In 2015, NOAA and the CDC created the National Integrated Heat Health Information System (NIHHIS), in response to the growing threat from extreme heat.[36] NIHHIS aims to enhance understanding and information on health concerns linked with extreme heat, create science-based solutions and build capacity and communication networks to promote resilience.[37] NIHHIS also provides heat-health resources, including current forecasts, predictions and information, case studies, reports, and tools to help reduce risks to extreme heat.

The National Weather Service (NWS) has several tools to evaluate the heat stress potential caused by high temperatures.[38] The heat index tool measures how the temperature feels to the human body when relative humidity and air temperature are both considered.[39] Temperature, humidity, wind speed, solar radiation, and other environmental factors are used by the Wet Bulb Globe Temperature (WBGT) tool to provide guidance on exercise or outdoor work.[40] The prototype HeatRisk tool forecasts heat for a given location, and identifies groups that may be most at risk at that heat level.[41]

Local Interventions to Build Adaptation and Resilience

[30] https://www.pnas.org/content/113/42/11770.short
[31] https://www.worldweatherattribution.org/wp-content/uploads/NW-US-extreme-heat-2021-scientific-report-WWA.pdf
[32] https://link.springer.com/article/10.1007/s10584-014-1154-8
[33] https://www.worldweatherattribution.org/wp-content/uploads/NW-US-extreme-heat-2021-scientific-report-WWA.pdf
[34] https://link.springer.com/article/10.1007/s10584-014-1154-8
[35] https://www.ajpmonline.org/article/S0749-3797(08)00686-7/fulltext
[36] https://toolkit.climate.gov/topics/human-health/extreme-heat#footnote1_qst5cyw
[37] https://cpo.noaa.gov/Serving-Society/NIHHIS/About-NIHHIS
[38] https://www.weather.gov/safety/heat-index
[39] https://www.weather.gov/ama/heatindex
[40] https://www.weather.gov/car/WBGT
[41] https://www.wrh.noaa.gov/wrh/heatrisk/

Local officials can establish heat early warning systems to provide timely notification of prevention measures to vulnerable populations to reduce heat-related illnesses and raise awareness about risk factors.[42] Air conditioning (AC) may be the most effective way to prevent heat-related illnesses; however, almost one-third of U.S. housing units do not have any type of AC on average, with this percentage being much higher for Black and Hispanic households.[43] The use of cooling centers, or airconditioned buildings designated as a safe location during extreme heat, is a common strategy used by public health departments and other local partners to protect the public during extreme heat events. However, there is evidence that cooling center locations do not consider the spatial distribution of different vulnerable groups.[44]

A growing number of communities and states such as Phoenix, Arizona[45] and Ahmedabad, India[46] have implemented heat action plans to help prepare for and manage heat-related health impacts, including developing early warning systems and response measures that focus on vulnerable populations.[47] Evidence suggests these plans can reduce health risks through interventions to raise awareness and educate the public, enhance observation and monitoring of impacts, provide access to cooling centers, and reduce urban heat islands through design and modifications to infrastructure.[48]

Long-term strategies to build resilience to extreme heat focus on changing or adapting building materials such as installing cool roofs and reflective pavements and adding more green spaces. These interventions can be expensive, but some cities are undertaking such measures. For example, the Los Angeles Urban Cooling Collaborative is a multi-disciplinary partnership of universities, non-profit organizations, government agencies, and others with the goal of understanding and implementing urban cooling strategies in the Los Angeles region.[49]

Research Gaps

While progress has been made in monitoring, predicting, and forecasting extreme heat events, many other research and coordination gaps remain. There is no standardized definition of heat-related health effects. Standard methodologies to track the effects and understand the adaptations should also be adopted. Further, the risk factors for illness and death correlated with longer term exposure to extreme heat and higher average temperatures need to be understood, defined, and monitored.[37] Global health data and the linked climate data (especially from developing nations) should also be accessible for researchers to enhance their study of the current and future health effects of climate change.

[42] https://www.epa.gov/heatislands/adapting-heat
[43] https://www.ncbi.nlm.nih.gov/pmc/articles/PMC8125005/
[44] Ibid.
[45] https://www.nature.org/content/dam/tnc/nature/en/documents/Phoenix-Arizona-Heat-Action-Plan.pdf
[46] https://www.nrdc.org/sites/default/files/ahmedabad-heat-action-plan-2016.pdf
[47] https://iopscience.iop.org/article/10.1088/1748-9326/ab5ab0
[48] Ibid.
[49] https://www.treepeople.org/rx-for-hot-cities-climate-resilience-through-urban-greening-and-cooling-in-los-angeles/

The lack of public awareness about the dangers posed by extreme heat further increases threats. Media reports often fail to report the threats or mislead residents, sometimes presenting heat waves as something positive.[50] Threats need to be clearly understood and communicated to vulnerable communities.

[50] https://insideclimatenews.org/news/16052021/extreme-heat-risks-climate-change/