

S&T R&D IMPACTS UPDATE

NATIONAL PREPAREDNESS MONTH – 2022



Science and
Technology

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There are many examples today for understanding how natural disasters and changes in climate are disrupting our lives and testing our country's defenses. Increasingly, extreme weather is directly connected to year-round droughts, wildfires, floods, and historic temperature warnings across the country, which impacts our economic, health and secure well-being. As these challenges persist, the U.S. Department of Homeland Security [Science and Technology Directorate \(S&T\)](#) is playing an essential role in getting ahead of future risks, by harnessing scientific discoveries and technological advances that enhance the nation's resilience and ability to adapt to current and projected emerging threats.

When minutes or seconds can make a difference in responding to an isolated or cascading event, DHS Components and state and local officials call upon S&T's deep scientific expertise, including DHS laboratories, university Centers of Excellence, and industry partners, to ensure hazard and risk modeling and emergency preparedness remains current with the changing security landscape. As an authoritative federal government resource for understanding homeland security requirements and investing in research and development (R&D) to solve problems, the following innovative solutions demonstrate how S&T is investing in science to develop new technologies that achieve greater impact where the needs are greatest for enhancing disaster preparedness and resilience for the nation.

EXTREME HEAT INNOVATIONS >>>

Across the U.S., heat waves are causing more fatalities than any other type of severe weather event. At S&T, protecting vulnerable Americans from heat-related illness and death during extreme heat conditions or in connection with other disasters is an important part of our disaster resilience and adaption R&D investments.

In response to this challenge, S&T recently co-hosted a prize competition with FEMA called the [Cooling Solutions Challenge](#). This R&D prize initiative entails developing innovative cooling solutions to help first responders and state and local communities get access to technologies or other means of keeping cool during extreme heat conditions, including during power outages. S&T and FEMA are working with Challenge winners to develop solutions to improve air conditioning via liquid desiccant dehumidification and evaporative cooling solution, leverage cooling textiles for clothing, solar shades and temporary structures. One winner is using nature as a guide to create innovative cooling apparel.

The Challenge focused on identifying energy efficient, cost effective, and scalable solutions, which could allow for alternate power sources. A panel of experts in climate change and emergency management [selected the winners](#) using criteria that will help communities counter extreme heat events. S&T plans to announce the next climate change prize competition in early 2023, which will be a series of R&D initiatives to engage the innovation community and citizen inventors to find creative solutions to address complex climate and resiliency issues.

WILDFIRE DETECTION CAPABILITIES >>>

Days of scorching temperatures, extreme dry conditions, and high winds are contributing to year-round wildfires. S&T researchers are teaming up

“Extreme heat is the leading cause of weather-related deaths in the country, often hitting underserved communities the hardest. By partnering with S&T on this Challenge, we are bringing together and empowering bright minds with bold ideas to solve one of our nation's most dangerous and complex climate challenges.”

*Deanne Criswell,
FEMA Administrator*



THE COOLING SOLUTION
WINNERS ANNOUNCED!

with FEMA, industry, and state and local fire agencies to develop new capabilities to combat this growing threat. This year, S&T's Smart Cities Internet of Things Innovation (SCITI) Labs program started long-term field test deployments of real-time, continuous monitoring and early detection smart sensors to enhance wildfire alerts and warnings. These technology solutions provide geographically targeted alerts and notifications to rapidly respond to early-stage ignitions that could prove the difference between a localized fire response and a large-scale tragedy. A network of intelligent sensors allows first responders to get to the source of ignition sooner to suppress an initial blaze before it spreads out of control and plan for potential evacuations.

Known as the [Commercial First Innovation](#), SCITI encourages governmental, academic, and private sector innovators to develop, test, and evaluate technologies for public safety effectiveness and marketplace viability. With a focus on applying new and existing technologies to public safety needs, SCITI ensures technologies have a path-to-market and are scalable to suit diverse DHS missions.



WILDLAND FIREFIGHTER HEALTH AND SAFETY IMPROVEMENTS >>>

S&T research findings indicate wildland firefighters are increasingly exposed to toxic chemicals they had not previously encountered in such high volumes. However, current respiratory protection systems are often unable to perform effectively under extreme outdoor front-line conditions. Unlike structural firefighters, wildfire responders do not wear heavy gear that filters and provides clean air because the gear is too unwieldy and limited to sustain long-hours and high-exertion efforts.

S&T is saving lives by improving firefighter personal protective equipment (PPE). Extreme heat from the flames and hiking long distances

“The earth is changing. Five of the worst wildfire years ever in our history have occurred in the last seven calendar years. We must adapt as our mission is evolving. S&T is focused on these issues - they invite first responders to the table and ask us what we need and what we think.”

*Jay Hagan,
Fire Chief, Bellevue, Washington*

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with heavy equipment often leads to heat stress and exhaustion. Recently, in South Carolina, S&T's [National Urban Security Technology Laboratory \(NUSTL\)](#) operationally field tested a lighter, less restrictive [Wildland Fire Respirator](#) system, capable of removing airborne hazards present in the wildland firefighting operating environment. While S&T works to transition the new respirator system to the marketplace, NUSTL is teaming up with [Department of Energy's Pacific Northwest National Laboratory](#) to evaluate currently available equipment that can guard against gas hazards and particulates from wildland fires. A market survey report of air purifying respirators will be published in the [SAVER Document Library](#) for access by state, local, federal, tribal and territorial response agencies making procurement decisions about respiratory protective gear.

Recognizing the urgency to do more, S&T is also leading R&D efforts with industry and agency partners, including CAL Fire and the U.S. Fire Service, to test and evaluate firefighter equipment so that it continues to mitigate exposure to hazardous threats. Over the past decade, [S&T's First Responder Resource Group \(FRRG\)](#), the DHS and state and local operational requirements coordination body, has worked closely with [S&T's First Responder Capability program](#) to test more than 1,000 prototype garment ensembles, improving the radiant thermal protection and overall function of nationwide wildland firefighter PPE. Today, with more than 30,000 sold, these [advanced garments](#) are commercially available and have been in operational use by CAL Fire since 2016.

EARTHQUAKE PREPAREDNESS >>>

With funding support from S&T and FEMA, the Central U.S. Earthquake Consortium (CUSEC) has developed a data collection, visualization, and reporting application for screening buildings for potential earthquake vulnerabilities. The [CUSEC Rapid Visual Screening \(RVS\)](#) application incorporates procedures from FEMA to identify and inventory buildings that may be vulnerable to earthquake shaking. Since initially developing the application with S&T scientists and engineers, CUSEC has successfully deployed and transitioned it to Missouri and Tennessee, which are performing pre-earthquake screenings of buildings for potential seismic hazards.

In 2023, CUSEC will be partnering with other states, including Arkansas, Illinois, Indiana, Kentucky, and South Carolina to use the RVS application to catalogue screen critical facilities and infrastructure in seismically prone areas. Data collected from this project will be used to inform earthquake mitigation, response, and recovery plans at the local, state, and regional level.

FLOOD RESILIENCE TECHNOLOGY & TOOLS >>>

Anticipating more frequent and intense flooding in the future, [S&T's First Responder Capability](#) and [Community and Infrastructure programs](#), are making risk-informed investments and evaluating technologies to protect people, property, and infrastructure. With scientists expecting torrential rainstorm events at any given location to get heavier in the years ahead, addressing those underlying stressors which disproportionately impact the most vulnerable populations, is another top challenge for S&T.

Recent downpours across the country continue to break century-old records, destroying communities, and causing fatalities. In July 2022, eastern Kentucky, and central Appalachia experienced rainfall over 600 percent the normal rate. In cases like this, the faster disaster information



“With the number of increased storms and extremely high consequences, S&T understands our daunting challenges to overcome obstacles and get our communities back up and running. Through S&T's support, Kentucky is establishing simpler, cost-efficient, and uniform methods for keeping communities better prepared for future risks.”

*Carey Johnson,
Director, Kentucky Division of Water*

can be securely shared, the faster communities can be restored, and survivors can rebuild.

Following recent natural disasters, including flash flooding and tornados, the Commonwealth of Kentucky reached-out to S&T for help with improving their disaster information sharing capabilities. After meeting with local and state officials, including Kentucky Emergency Management, S&T mobilized partners from FEMA, the Central United States Earthquake Consortium, and the Virginia Innovation Partnership Corporation, to develop and deploy the [Recovery Planning Tool \(RPT\)](#).

With a focus on assessing damages and assisting the public, the RPT improves how interagency partners coordinate on tracking, finding, sharing, and securing life-saving information needed to expedite disaster response and recovery efforts.

To further ensure communities become more resilient and can adapt and recover from extreme weather threats, S&T partnered with the Netherlands Deltares research laboratory to develop the [Community Flood Resilience Support System \(CFRSS\)](#) to provide state and local officials with improved decision support tools to better understand the risks related to compound floods.

“With two-to-four feet of sea level rise predicted over the next 50 years, CFRSS improves disaster resilience planning by enabling us to quickly anticipate specific threats and identify different adaption pathways we must explore.”

*Dale Morris,
Chief Resilience Officer,
Charleston, South Carolina*

CFRSS models flooding, and damage caused by the combined effects of tides, storm surges, inundated precipitation, and river discharge, which helps state and local officials better prepare for different risk scenarios and implement mitigation solutions that can save lives and property. To best prepare for changing conditions, it can do both a full risk assessment using multiple scenarios as well as a 'what if' analysis for a single storm event. Impacts can be calculated as

economic damages (based on land use classes and depth-damage functions) as well as number of assets (houses, roads) hit. In addition, to help evaluate appropriate response strategies, CFRSS offers fast calculations that allows emergency planners to explore different sea level rise and solution scenarios.

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FLOOD RESILIENCE INFRASTRUCTURE >>>

Across the country, a failure of a dam or levee can generate catastrophic floods, leading to loss of life, urban and agricultural property damage, and cascading failures to other critical sectors. Without reliable information on how flood waters (over a breached levee or dam) will spread to homes, building, roads, and bridges, emergency officials face challenges issuing evacuation and shelter-in-place orders.

To address this challenge, S&T collaborated with researchers at the National Center for Computational Hydroscience and Engineering (UM-NCCHE) at the University of Mississippi and colleagues from FEMA, CISA, and the Army Corp of Engineers, to develop the Decision Support System for Water Infrastructural Security (DSS-WISE™).

“DSS-WISE™ is invaluable as a decision support tool for the emergency management community because it can do a sophisticated analysis and simulate a dam break within half an hour, to an hour. That is where the real strength is.”

James Demby,
Senior Technical and Policy Advisor
National Dam Safety Program, FEMA

This solution enhances modeling and simulation capabilities for dam and levee failures and storm/tidal surges, to improve the management of water infrastructure. Using state-of-the-art, 2D numerical flood models and a series of geo-graphic information

system (GIS)-based decision support tools, DSS-WISE™ calculates the speed at which water would advance, the depth, and extent of land and infrastructure impacts, providing emergency planners with data needed to target populations and prioritize affected regions.

HURRICANE RESILIENCE PROTECTIONS >>>

Chemicals are produced and shipped in bulk and transported across the country daily and are in danger of being impacted by hurricane conditions. In advance of hurricane season and tropical storms, emergency managers need actionable information about chemical threats and hazards to be fully prepared.



S&T's [Chemical Security Analysis Center \(CSAC\)](#) operates a 24/7 Technical Assistance hotline ([410-417-0910](tel:410-417-0910)) to help officials determine the likely hazards resulting from a potential release. After the path of a hurricane is identified, and hazardous chemicals are located at chemical plants, CSAC uses science-based chemical modeling and analytical tools to inform preparedness efforts and assist with response activities.

Being ready, proactive, and knowledgeable of risk levels is central to CSAC's mission. CSAC is the nation's only federal study, analysis, and knowledge management center for assessing the threats and hazards associated with an accidental or intentional large-scale chemical event or chemical terrorism event in the U.S. For the Department and nation, CSAC answers the call on how investments in chemical threat and hazard analysis laboratory research and science are providing valuable tools and capabilities in areas like transportation screening, chemical and biological threat mitigation, and first responder technologies.

HURRICANE PREDICTION CAPABILITIES >>>

Given the devastating impacts of hurricanes and tropical storms, preparation is vital to saving lives and property. The [Coastal Resilience Center \(CRC\)](#), a [DHS Center of Excellence](#) led by the University of North Carolina at Chapel Hill, in partnership with Jackson State University in Jackson, Mississippi, developed the [ADvanced CIRCulation \(ADCIRC\) Prediction System™](#) to improve coastal flood and storm surge modeling to get people and property out of the path of dangerous storms.

ADCIRC provides timely, event-based, high-resolution storm surge forecast guidance to help FEMA and state and local emergency management agencies prepare for potential hurricane impacts and to pre-position resources, rescue craft and personnel.

ADCIRC applications include flood risk mapping and coastal infrastructure design, which can be combined with other models to predict the cascading consequences of extreme storm surges and flooding and winds impacting critical infrastructure. This technology solution enables emergency managers to identify which coastal locations will become unsafe, allowing them to plan for mitigation and response before severe storms occur.

Did you know:

- **9-out-of-10 hurricane fatalities are related to storm-surge and in-land flooding.**
- **From New Orleans to New England, hurricane preparedness is not limited to coastal communities. More than 80 million people live in areas that could be impacted by hurricanes.**

CIVIC INNOVATION CHALLENGE FOR COMMUNITY RESILIENCE >>>

Many communities were not built for the scope and size of the extreme disasters we face today. Our partnerships with the National Science Foundation (NSF) and Department of Energy (DOE) to co-host the [CIVIC Innovation Challenge \(CIVIC\)](#), represents a new research model for defining community-based problems, addressing neighborhood scale, applying best practices, and building capacity to close gaps in resilience equity.

CIVIC projects addressed one of two community-identified tracks: Communities and Mobility, or Resilience to Natural Disaster. A list of the solutions awarded by S&T to enhance community resilience, within a 12-month timeframe, can be found [here](#).

By targeting under-resourced communities, which natural disasters often impact the most, CIVIC accelerates the transition of foundational research and emerging technologies directly into local and regional communities. Through on the

ground coordination with emergency responders, S&T is mobilizing science and engineering expertise to develop community-based solutions and make them sustainable and transferrable across the US.

In 2021-22, S&T worked with more than 52 nationwide communities, including universities, NGO coalitions, and state and local governments, to pilot research-centered solutions to enhance community resilience to natural disasters. Examples of where S&T investments are making impacts, include:

- Addressing disproportionate harm to older Americans and those with assisted and functional needs during natural disasters using a secure

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data exchange hub to share health and medical information of older adults with first responders during evacuations in Anaheim and Santa Rosa, California.

- The displacement and recovery time for low- and middle-income households and medically fragile households is disproportionately high following a disaster. The matching of converging supply (donated materials and volunteer labor) with the need for repair of damaged homes among particularly vulnerable and medically fragile households is less than optimal. To reduce displacement times, one project in Hampton Roads, Virginia, is developing a platform that plans for these disasters, and more optimally matches donated materials and volunteer labor with the post-disaster needs of these vulnerable households.
- Remote sensing data and citizen engagement are being used to reduce data gaps in flood hazard modeling in rural communities in the Michigan Upper Peninsula. Standard flood modeling is prohibitively expensive for many smaller communities, but citizen participation in the process breaks down those barriers and increases public awareness of risks.
- Inclusive flood insurance is being developed that provides emergency cash grants to low- and moderate-income (LMI) households based on flood sensor data in New York City. This project is increasing the financial resilience – the ability to recover from an economic shock – of LMI households in New York City from escalating flood risks. Another NYC project is standardizing how data about underground infrastructure is shared so that crucial improvements can be made before natural disasters.
- Teaming up with Native American Pueblo tribal communities to co-develop low-cost sensors and embed them across the Ohkay Ownigeh in north central New Mexico. Decision support sensors enable the public to gather and leverage data to prepare for wildfires and floods and provide early warning notifications. This co-creation process increases Tribal community trust and potential for future collaborations in research and implementation to enhance resilience.

A list of all CIVIC Stage 2 awarded solutions and the teams of cross-sector research partners, can be viewed on this [interactive CIVIC map](#).



MOVING FORWARD »»

With an evolving security landscape, a chief S&T priority is to understand the impacts of emerging threats on our society and transition new technologies to enhance national preparedness. At both the community and national level, S&T's R&D mission is to ensure the country has the tools needed to keep pace with change and adapt to what comes next.

The fact that we are seeing more complex threats, critical infrastructure vulnerabilities, and intensified natural disasters means we must continue to push the boundaries of science and technology. With a focus on rigorous scientific analysis and operationalizing technological advances, S&T will continue to lead the Department and nation in mobilizing innovation to enhance national preparedness and community resilience.

“Knowing each community is unique and affected and equipped differently to carry-out life-saving missions, S&T is a trusted resource for solving complex problems and delivering solutions that are transferrable across diverse regions and localities.”

*Catherine Cross,
Senior Official Performing the Duties
of Deputy Under Secretary, DHS S&T*

To learn more about how **S&T R&D investment impacts** are transferring solutions to securing the quality of life for all communities, stay connected to S&T over these platforms.