Climate Resilience Centers Awards

Summary of projects awarded in 2024 under Funding Opportunity Announcement DE-FOA-0003181

Projects

- Advancing Development and Climate-Resilient Adaptation Practices via Community-Driven Urban Transformation in St. Louis, MO
- The Climate Lighthouse: DOE-CCNY Urban Climate Hazard Resilience Center
- Climate Resiliency Center for Building Adaptive Capacity in Tribal Communities Along Missouri River Basin
- Coastal Bend Climate Resilience Center: Enabling Equitable Resilience for Compound Hydrologic Extremes Along the Texas Coast
- Midwest Climate Resilience Center: Soil Systems Scale Up
- A Climate Resilience Center for Alaska
- Space Coast RESCUE (Resilience Solutions for Climate, Urbanization, and Environment)
- Building Predictive Capacity to Enhance Stormwater Infrastructure and Flood Resilience
- Massachusetts Gateway Cities Climate Resilience Center: Powering a Just and Resilient Future
- A Regional Climate Resilience Center for Water Extremes Adaptation Strategies Implementation

Understanding fine-scale, local, and community impacts of climate change across America is a critical gap in climate research and analysis today. Climate change disproportionately impacts people in disadvantaged communities due to increased exposure and vulnerability.

Climate resilience is a community or region's ability to reach full recovery after being exposed to climate-induced stresses and damages using strategies that adjust its adaptive capacity at minimal impact to natural, socioeconomic, infrastructure, and financial systems. A key component of climate resilience involves using high-fidelity models to predict climate change–induced stresses and damages to systems.

The U.S. Department of Energy's (DOE) Office of Science's Biological and Environmental Research (BER) program selected 10 projects in fiscal year 2024 to increase the use and utility of DOE research to improve climate resilience, particularly in vulnerable communities.

Climate Resilience Centers (CRCs) will empower local universities to use DOE climate science to help tackle problems posed by a changing climate. CRCs will build and enable young scientists, engineers, and technicians to use DOE climate science and capabilities at national laboratories, scientific user facilities, and universities and translate research results into practice among community stakeholders for improved local climate resilience.

CRCs will extend DOE climate science, capabilities, and research by supporting historically black colleges and universities, non-R1 minority-serving institutions, and emerging research institutions to address regional resilience needs and impacts on natural, socioeconomic, and built systems and their intersections.

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DOE Office of Science
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U.S. Department of Energy
energy.gov

2024 Awards

Advancing Development and Climate-Resilient Adaptation Practices via Community-Driven Urban Transformation in St. Louis, MO

Principal Investigator: Orhun Aydin (Saint Louis University)

Advancing Development and Climate-Resilient Adaptation Practices via Community-Driven Urban Transformation in St. Louis, MO (ADAPT-STL), a CRC based at Saint Louis University, will act as a foundation to build regional resilience to heat islands in St. Louis. ADAPT-STL will generate primary data on the local climate of St. Louis, Mo., via a community-driven, semi-stationary weather station network and develop a super-resolution model for urban micrometeorology using DOE's Energy Exascale Earth System Model (E3SM). The model will integrate climate data from E3SM, the urban footprint, and the local weather station network and develop a generative convolutional network model to define equiprobable climate scenarios constrained to E3SM.

In addition, ADAPT-STL will develop a decision support tool with community and local government representatives to plan green and gray infrastructure interventions for heat resilience. The decision support tool will utilize decision-making uncertainty principles, game theory, and spatial optimization to determine multiple scenarios of infrastructure design to combat urban heat islands. The tool will enable urban planners and decision-makers to assess various options for future development of sustainable urban infrastructure.

The CRC addresses the call for community-centric resilience building by engaging local communities to define climate risk's impacts and evangelizing the impacts of climate change on St. Louis. ADAPT-STL will empower communities with tailored climate data products to quantify resilience, make plans, and support community resilience projects by serving as a bridge between local communities and decision-makers to develop equitable climate resilience capacity with green infrastructure projects.

ADAPT-STL's mission is to foster a resilient St. Louis by harnessing the power of community engagement, cutting-edge science, and collaborative decision-making. The CRC is dedicated to transforming the way cities confront and adapt to climate change, with a particular focus on combating the urban heat island effect. In addition to the scientific and societal goals previously described, the center will serve as an interface of climate modeling and community by establishing sustainable partnerships with local community organizations. Local partners will be selected to represent different kinds of engagement involved in climate resilience decision-making. Throughout the performance period, ADAPT-STL will foster collaborative partnerships with local community members, nongovernmental organizations that represent communities, urban design divisions of St. Louis City and County, and decision-makers.

The Climate Lighthouse: DOE-CCNY Urban Climate Hazard Resilience Center

Principal Investigator: James Booth (The City College of New York)

As a collaboration between The City University of New York (CUNY) and DOE, the Climate Lighthouse will focus on the most significant and impactful climate risk for New York City (NYC) in the next 20 years: extreme heat. The CRC aims to add to CUNY's unique track record of empowering underserved urban communities in NYC. The project will focus on collaborative translational science by working closely with people living in underserved, high-population-density communities. This two-way communication between researchers and the public is necessary to build resiliency toward climate change hazards at the community scale.

The project will translate DOE climate model data into usable tools to improve NYC's resilience to future heat waves. The project will (1) improve the quantification of heat hazards and social vulnerabilities to heat in the present and on future timescales of 5, 10, and 20 years and (2) create a methodology for communicating with community groups about changing heat hazards. These outcomes can be translated to any other city in the United States. To improve heat hazard quantification, high-resolution climate model data generated by E3SM will be used to identify changes in the summer climate as well as specific heat wave events in the future climate. For these events, the project will use a high-resolution numerical model to downscale the DOE model data to a subkilometer scale, and additional statistical modeling will capture even finer spatial scales in NYC neighborhoods most vulnerable to heat hazards. The work will generate maps of the likelihood of heat waves as well as graphs demonstrating the intensity, duration, and frequency of current and potential future heat waves for NYC communities. The CRC will develop heat hazard storylines of worst-case climate change scenarios and compute uncertainties around the most likely projected changes. The team will also develop a new finer-scale heat vulnerability index considering existing demographic and socioeconomic data. For future projections, the project will generate multiple scenarios of population change to provide an envelope of potential future vulnerability. The population projections coupled with the heat storylines will be, to the team's knowledge, the first of their kind to harmonize climate model data with demographic data at fine spatial scales for future vulnerabilities.

The CRC will create a novel mechanism for communicating data to the public using a participatory action process to engage both community and government stakeholders with researchers. The work will build on existing community partnerships in NYC, especially in the boroughs of Manhattan (Harlem) and Brooklyn. The team will work with community partners to iteratively improve these tools to build actionable knowledge among the public.

Climate Resiliency Center for Building Adaptive Capacity in Tribal Communities Along Missouri River Basin

Principal Investigator: Mengistu Geza Nisrani (South Dakota School of Mines and Technology)

DOE seeks to support a collaborative research project to enhance climate resilience among Native American communities along the Missouri River. The South Dakota School of Mines and Technology (SDSMT), Great Plains Tribal Water Alliance (GPTWA), Standing Rock Sioux Tribe (SRST), United States Geological Survey (USGS), and Pacific Northwest National Laboratory are establishing the Missouri River Basin Climate Resilience Center (MRB-CRC). The primary goal is to develop tools that translate complex climate projections into practical, site-specific information to help communities assess vulnerabilities to extreme weather events such as droughts and floods and to plan effective mitigation strategies. The project will create user-friendly decision support tools by integrating state-of-the-art climate data with advanced hydrologic models and machine learning algorithms, enabling informed water resource management decisions in the face of changing climate conditions. Specific objectives include (1) building a database of future climate projections for reservations to improve water resource management, (2) incorporating advanced climate projections with integrated hydrologic models, (3) developing user-friendly decision support tools based on data and Indigenous knowledge for water resource management, (4) conducting uncertainty analysis, and (5) engaging communities.

Decision support tools will be developed on a non-proprietary open-source platform, incorporating climate data, hydrologic models, and watershed inputs organized into a database. Hydrologic models will be developed by integrating physics-based models and machine learning algorithms to enhance prediction accuracy. A stakeholder-driven bottom-up approach will be used for decision-making, identifying strategies that meet community-defined criteria under plausible climate scenarios. Decision support tools will be tested through case studies on the Standing Rock Indian Reservation to evaluate projected climate change's impacts on water resources and associated uncertainties.

The MRB-CRC will provide several key benefits to the communities in SRST and other reservations in the northern Great Plains. The CRC will offer accessible future climate information to analyze drought and flood risks, employ advanced machine learning algorithms for water resource management and risk prediction, and develop decision support tools to optimize water use and select effective flood and drought mitigation strategies. Additionally, the decision support tools will serve as an educational resource for training students at Tribal colleges and universities (TCUs) in the Missouri River Basin. GPTWA and SDSMT will contribute to workshops organized by the consortium of TCUs to demonstrate research results and tools to provide insights into climate change's impacts on communities along the Missouri River. SDSMT and GPTWA will also contribute to the South Dakota water conferences organized by USGS. These efforts aim to enhance understanding of climate change impacts and prepare communities along the Missouri River for future challenges.

Coastal Bend Climate Resilience Center: Enabling Equitable Resilience for Compound Hydrologic Extremes Along the Texas Coast

Principal Investigator: Michelle Hummel (The University of Texas–Arlington)

Communities in the Texas Coastal Bend face threats from multiple hydrologic hazards, including floods and droughts. These events may be driven by complex interacting processes across the atmosphere-ocean-land interface and thus require advanced Earth systems modeling approaches to quantify. In particular, compound events, in which multiple processes interact to create hazardous conditions, are difficult to understand and predict. With climate change, patterns of individual and compound events are predicted to change, presenting a challenge for communities to effectively adapt to increasingly frequent and severe stressors. In addition, disadvantaged communities are often disproportionately exposed to and impacted by hazard events, highlighting an urgent need for adaptation strategies to support equitable community resilience.

The Coastal Bend Climate Resilience Center (CB-CRC) presents a convergent approach for basic and applied research and capacity building aimed at advancing understanding of the drivers and impacts of hydrologic multi-hazards to support equitable adaptation planning and hazard mitigation in the Texas Coastal Bend. The CB-CRC aims to:

- Leverage advanced Earth systems simulations, multivariate and multisite downscaling approaches, and local-scale impact models to uncover the relationships between compound event drivers and hazards and predict their evolution in the future climate;
- Co-develop adaptation strategies with stakeholder partners and test these strategies within the model framework to assess their efficacy at providing effective and equitable risk reduction; and
- Engage in meaningful outreach with stakeholders and community groups to identify information needs, disseminate project outputs, and build capacity to apply project outputs to inform decision-making.

Planning for future hazards requires predictions of how the frequency, intensity, and co-occurrence of multi-hazards will evolve in the future climate and how these hazards will manifest into exposure and impacts at scales relevant to planning (e.g., at the community or watershed scale). To address these needs, the project will leverage E3SM to capture relevant climate and terrestrial processes influencing hazards of concern in the Texas Coastal Bend. The project team will apply multivariate and multisite downscaling methods to E3SM model outputs to analyze the drivers of compound events across global-to-local scales. Researchers will then use the downscaled outputs to force finer-scale, process-based models that can predict local impacts on water availability, estuarine water quality, and urban flooding. The CRC will simulate a range of stakeholder-identified adaptation strategies to quantify the risk reduction and equity implications of each adaptation approach and to identify the potential for maladaptation, in which actions taken to mitigate one hazard's impacts could potentially exacerbate other hazards' impacts or lead to inequities in hazard exposure.

A critical component of the CB-CRC is building both short- and long-term capacity in Texas Coastal Bend communities to ensure local decision-makers and community leaders can effectively leverage scientific outputs to inform resilience-building efforts, particularly among underrepresented and vulnerable groups. To inform this work, the project team will assemble a Stakeholder Advisory Group to help guide the CB-CRC goals and approach, identify adaptation options to model, and provide feedback on model results to ensure alignment with community needs. The team will also develop a series of end-user workshops that engage and train a broader set of stakeholders and community representatives to understand and apply project outputs in their own decision-making processes, thus enabling wider dissemination and uptake. Finally, the project will include a translational research program that pairs graduate student researchers with end-users in structured, year-long discussions about the integration between scientific research and applied decision making. This translational research program will enable ongoing two-way communication between the project team and end-users, train students to work at the basic and applied research interface, and ensure CB-CRC products are directly relevant to regional adaptation planning.

Through basic, applied, and translational science activities, the CB-CRC will produce localized, decision-relevant information about future hydrologic multi-hazards in the Texas Coastal Bend. The resulting data products and capacity-building efforts will support equity-aware planning that mitigates negative impacts due to floods and droughts.

Midwest Climate Resilience Center: Soil Systems Scale Up

Principal Investigator: Sakthi Kumaran (Central State University)

Disadvantaged urban communities in the Great Miami watershed in Clark County, Ohio, are increasingly at high risk from extreme precipitation events and consequent drinking water–quality impairments from nitrates. The nitrates originate from agricultural nutrients in upstream rural watersheds draining into the urban watershed. The behavior and transport of nitrogen (N) are governed by the hydro-biogeochemical carbon (C) and N cycles. Increasingly wet spring and hot dry summer conditions, which are expected as climate change intensifies, will perturb these cycles, creating new risks to vulnerable populations. This project will develop models that link biogeochemical N and C cycling at molecular scales to watershed-scale groundwater flow (scale up) and to community responses, with the goal of strengthening climate change resiliency within these populations.

Equitable solutions for addressing climate stressors require an enhanced understanding of soil system responses to climate change and the resiliency of these systems at local scales. Although existing climate and Earth systems models (e.g., E3SM) highlight climate change impacts at regional and global scales, they can seldom be directly applied to local scales for policy-making. This scale gap represents an important weakness in the ability to deliver critical location-specific biogeochemical information to disadvantaged communities for informed policy-making to address increased exposure and vulnerability to climate change. This weakness is largely due to a lack of mechanisms to upscale from molecular to pedon (meter) to landscape. A key source of uncertainty in systems modeling, regardless of the scale, comes from the spatially variable structure, redox, and molecular processes in soil systems in natural and managed landscapes. The uncertainty in observations must be effectively integrated into system models at multiple scales during model parameterization.

Pedotransfer functions offer a systematic framework to link observational data at the pedon level to model parameters and serve as an effective tool for model integration and scaling up. Moreover, advancements in remote sensing (e.g., hyperspectral sensing), machine learning–based uncertainty quantification techniques, and high-performance computing can be used to scale up processes from the pedon to landscape scale. Advancements in analytical methodology (e.g., high-throughput Fourier transform ion cyclotron resonance mass spectrometry) for soil property measurements (e.g., proximal soil sensing approaches) provide additional new opportunities to improve the prediction accuracy of water, energy, and heat fluxes in systems modeling.

The CRC will focus on the issue of scaling as it relates to soil processes and systems involving climate stressors, current and anticipated impacts of climate stressors, and the subsequent effects on community health and prosperity. The project will accomplish the following long-term goals:

- Develop scale-appropriate targeted climate solutions that are equitable and participatory in the Midwestern region;
- Enhance DOE's Earth systems modeling effort through the much-needed local soil systems information, methods to integrate this information, and local partnerships; and
- Train the next generation of climate scientists from underrepresented student populations.

A Climate Resilience Center for Alaska

Principal Investigator: Richard Lader (University of Alaska–Fairbanks)

Alaska's landscape is experiencing transformational changes as a result of climate change where the observed rate of warming is more than 50% greater than the contiguous United States. This warming is contributing to unprecedented extreme events that are projected to continue, such as those related to permafrost thaw, sea ice loss, storminess, and wildland fire. These events are threatening built infrastructure on the landscape, decreasing energy security, and impacting the viability of traditional livelihoods. These impacts have been measured statewide with health outcomes and food security disparities and at the individual level with mental well-being. Given these challenges, the Alaska CRC will be a partnership between Los Alamos National Laboratory and the University of Alaska–Fairbanks (UAF) to bridge the gap between people who plan and implement climate resilience strategies and climate scientists who develop datasets to inform these strategies. The main objectives of the Alaska CRC are to:

- Communicate with Alaska communities about existing DOE science to make it actionable for climate resilience practitioners,
- Develop meaningful collaborations between Alaska communities and DOE partners via direct engagement and participation, and
- Incorporate DOE science into educational pathways and opportunities in Alaska as a means for sustained success.

DOE has invested in cutting-edge Arctic science programs such as the Interdisciplinary Research for Arctic Coastal Environments and the Next-Generation Ecosystem Experiments Arctic projects. However, this information needs to be shared with decision-makers for climate resilience efforts. The Alaska CRC will leverage the institutional capacity and relationships built with Alaskan communities provided by the International Arctic Research Center at UAF to meet its objectives. Activities will include information sharing with the Alaska Center for Climate Assessment and Policy, Alaska Tribal Resilience Learning Network, Alaska Climate Adaptation Science Center, and College of Rural and Community Development. These activities will identify unmet resilience needs and help steer future DOE research. The development of an expert panel on climate resilience early in the project, comprised of local knowledge experts, will help communicate unmet needs via two-way dialogue between communities and scientists, which will allow development of innovative products to support climate resilience. Conference meetings such as the Alaska Tribal Conference on Environmental Management, Western Alaska Interdisciplinary Science Conference, and Alaska Forum on the Environment will support face-to-face collaboration and relationship building.

While the Alaska CRC will be concerned with issues statewide, this project will focus pilot research on southwest Alaska to demonstrate the center's role. Successful climate resilience takes a holistic systems approach, targeting multiple stressors impacting a region, rather than viewing one type of event in isolation. In southwest Alaska, changes to snowpack and permafrost, extreme storms and precipitation events, and severe wildland fire collectively impact locals. Resilience activities focused on one type of event can provide valuable information for another. These pilot studies will use DOE modeling results to develop Arctic-specific metrics that:

- Capture and represent shifts in snowpack and permafrost for Alaskan communities,
- Study changes in extreme rainfall associated with flooding events that can lead to severe impacts within communities and strongly impact permafrost, and
- Assess decadal-scale projections of fire weather indices and extreme scenarios using an ensemble of high-resolution climate model runs, which have been archived on the DOE-supported Arctic Data Node at UAF.

The CRC will further explore compounding risk factors relevant to the Arctic environment. Examples include the combination of extreme coastal storms with minimal sea ice and heavy summer precipitation with above-freezing mean annual ground temperatures. Much of the pilot study research will involve CRC graduate students recruiting the next generation of climate investigators, with an emphasis on rural, traditionally underserved communities.

Space Coast RESCUE (Resilience Solutions for Climate, Urbanization, and Environment)

Principal Investigator: Steven Lazarus (Florida Institute of Technology)

The Florida Space Coast faces climate resilience challenges and risks representative of many coastal communities. These hazards include heat stress, extreme precipitation, hurricanes (e.g., wind, surge, and flooding), and coastal erosion. Inland flooding events are increasing due to development, heavy precipitation, and subsequent stormwater runoff, which also affect water quality and human health. For those living along Indian River Lagoon, a narrow 250 km long coastal estuary subject to many anthropogenic stressors including urban encroachment, the local flooding risks are increased. The combination of climate change and associated economic stresses is particularly acute in coastal communities' marginalized areas. In recent years, energy costs and homeowners' insurance rates have nearly doubled and are three times the national average. These challenges disproportionately impact the disadvantaged, creating roadblocks to clean energy solutions and climate resilience efforts in areas with the greatest needs.

To address these challenges, Florida Institute of Technology has partnered with Argonne National Laboratory (ANL) and a local grassroots organization on a climate resilience project that will (1) engage with local disadvantaged communities by collaborating with grassroots nonprofits and Title 1 schools on Florida's Space Coast, (2) use new and existing ANL datasets and model simulations to provide comprehensive information to stakeholders and community leaders on climate impacts and coastal resilience, and (3) formulate practical adaptation strategies.

In particular, the CRC will:

- Identify weather patterns impacting the local sea breeze and relate these to summer rainfall and, in the case of tropical storms and hurricanes, to extreme coastal and lagoon-related flooding from the combined effects of heavy rainfall and wind-driven water;
- Identify the impact of urban heat islands and precipitation changes on future heat stress;
- Conduct audits and drone-supported thermal mapping to assess current building energy use and efficiency to identify ways to reduce energy consumption;
- Perform model simulation of buildings in disadvantaged areas with downscaled future climate data to evaluate increased energy demands due to climate change and explore cost-effective solutions; and
- Engage the underserved community in citizen science and crowd-sourcing projects related to flooding and heat island monitoring.

The CRC will promote outreach and science translation by supporting a liaison position between the project and underserved community, participating in a local summer educational camp, hosting climate resilience forums, and developing climate-resilient community gardens.

An essential component of the project is to establish proactive and cost-effective strategies that effectively address local climate issues, enhance and inform urban infrastructure, and safeguard the environment. The CRC's solutions will involve the development of evidence-based best practices, maps of neighborhood heat stress and flooding, and building energy tools that aid in urban planning in the Space Coast's underserved community.

Building Predictive Capacity to Enhance Stormwater Infrastructure and Flood Resilience

Principal Investigator: Wendy Robertson (Central Michigan University)

In Michigan, there is growing awareness of the impacts of events driven or exacerbated by climate change; however, communities often lack data, models, and tools to quantify risk and evaluate potential future responses. Communities face a significant challenge interpreting how widely available global or regional predictions of climate change impacts translate to risks, scenarios, and planning pathways at the temporal (e.g., 10- to 30-year planning cycles) and spatial scales (e.g., community, city, watershed) where local decision-making occurs. This task can be further complicated by complex feedback processes that drive local-scale weather circulations and climate, especially in communities influenced by the Great Lakes. The CRC will address this challenge by leveraging DOE modeling platforms and outputs, project-coordinated citizen science data collection, and participatory modeling and scenario planning to (1) produce watershed and community-level midcentury climate and flood risk data, tools, and visualizations and (2) develop a framework to support informed decision-making for Michigan. The CRC aims to:

- Generate extreme value and event-based models of precipitation frequency and intensity. Use these outputs to explore the shifts in flood frequency, magnitude, and distribution for midcentury, and generate an ensemble of plausible futures.
- Analyze midcentury projections to assess potential environmental impacts, socioeconomic costs, and resilience strategies.
- Generate community-level flood inundation maps from model output that visualize spatial and temporal shifts in flood risk and impacts from plausible scenarios.
- Combine model output with stormwater models to evaluate the hydraulic performance of existing and potential stormwater infrastructure under plausible future conditions.
- Combine community demographic and property value data to develop an economic loss model for flood risks that highlights the potential disparities in impact across communities and neighborhoods in pilot watersheds.

- Leverage community co-created data and knowledge on flooding to co-produce analyses, scenarios, and tools to address flood resilience in three Michigan watersheds to aid in informed decision-making and the development of equitable solutions.

The CRC will use statistical and dynamic approaches to downscale climate models to produce output at the spatial and temporal scale relevant to communities. Dynamic downscaling will use coupled models from DOE's Coastal Observations, Mechanisms, and Predictions Across Systems and Scales–Great Lakes Modeling project, which incorporates the Great Lakes' effects on local climate and at fine enough scale (4 x 4 km) to resolve convective processes that contribute to extreme precipitation in Michigan. The team will use downscaled data to develop statistical distributions of precipitation that will be input to hydrologic and hydraulic models to simulate future flood magnitudes and inundation potential in pilot communities. Precipitation projections will also be used in urban stormwater models to simulate infrastructure's performance under future conditions and test different adaptation approaches. The CRC will collaborate with communities in three pilot watersheds in Michigan: the Chippewa River, Lower Grand River, and Rouge River watersheds. Through knowledge co-creation activities including citizen science and participatory modeling and scenario planning, community partners and project staff will collaborate to co-develop flood data, tools, scenarios, and solutions.

This project will produce data and tools to help communities plan for and become more resilient to climate change. This project will also extend beyond the three pilot watersheds as the CRC's framework and specific data outputs will be relevant to communities across Michigan. Proposed modeling work also leverages several DOE projects, and the team will have ongoing communication with these groups to provide feedback to improve models and data.

Massachusetts Gateway Cities Climate Resilience Center: Powering a Just and Resilient Future

Principal Investigator: Juliette Rooney-Varga (University of Massachusetts Lowell)

The Massachusetts Gateway Cities Climate Resilience Center (Massachusetts Gateway CCRC) will provide community-driven climate resilience science and implementation relevant to small- to midsized post-industrial, or 'gateway,' cities. These cities are disproportionately home to vulnerable communities and face associated resilience challenges and opportunities. While the initial focus will be on Lowell, Mass., the CRC aims to develop a model for community-driven climate resilience science and implementation that will be replicable and scalable to similar cities across Massachusetts and the United States. The CRC will work with the community to use DOE science and tools to provide locally relevant projections of extreme temperature events and to assess the related vulnerability and potential mitigation measures in terms of urban tree cover and green spaces, residential heating and cooling demand, and associated power demand. This research will produce actionable information over the course of the project; be scalable and replicable to other regions; and establish a center, toolset, and network of relationships to continue to develop climate resilience in underserved communities.

Both extreme temperature impacts and the challenges associated with electrifying heat are exacerbated in gateway cities. The Massachusetts Gateway CCRC responds to these challenges by fostering community-driven resilience research and implementation. The CRC will collaborate with community leaders and members to conduct three tasks: (1) extending DOE climate science to improve fine-scale projections of extreme temperatures in local gateway city environments; (2) determining how urban vegetation affects projected local temperature extremes and exposure of vulnerable communities in gateway cities; and (3) assessing how different local climate and building energy transition scenarios affect exposure of residents to extreme temperatures and energy demand patterns. DOE science tools will include E3SM, E3SM Land Model, and EnergyPlus models. To ensure research is co-designed and co-developed with community partners, the CRC will take a three-pronged approach that includes ongoing work with community leaders through a Climate Resilience Leadership Circle, direct outreach to diverse community members through Climate Cafes, and a Systems Mapping exercise that builds strategies for implementation and future CCRC work.

The CRC will improve community-level climate resilience by developing and providing information on ways to reduce energy use and exposure to climate extremes. This information will be uniquely valuable because it will be developed in collaboration with the community and provided at the community scale. Graduate students and a postdoctoral associate will be trained in community-engaged climate and energy modeling research. The CRC will also develop and launch a center with a framework of relationships and tools that can be scaled to other regions. The framework will also apply DOE tools and science to other ongoing and future challenges in gateway city resilience as climate extremes continue to amplify and the energy transition accelerates.

A Regional Climate Resilience Center for Water Extremes Adaptation Strategies Implementation

Principal Investigator: Y. C. Ethan Yang (Lehigh University)

Local and regional governments in the United States create climate action plans (CAPs) to help communities adjust to climate change through strategies for residents' daily lives. These CAPs often include measures to deal with severe water-related issues like floods or droughts. CAPs must consider the needs of socially vulnerable groups as they are most affected by climate change but have the least resources to manage its impacts. To aid these efforts, a new DOE-supported CRC will be established through a collaborative effort involving Lehigh University, the University of Houston, Florida Atlantic University, and Pacific Northwest National Laboratory. The center will use advanced data analytics and modeling to study how extreme water events like floods and droughts affect specific locations and their residents. The CRC will focus on three main areas:

- Evaluating how multiple local government CAPs coordinate efforts within a region;
- Investigating whether various adaptation strategies increase or reduce their intended impacts; and
- Assessing how different community groups, particularly those that are socially vulnerable, respond to these strategies.

The CRC aims to support its overarching scientific goal through three primary research tasks. The first task involves processing global climate data, such as precipitation and temperature, to regional specifics and comparing different climate change projections. The CRC will also conduct a regional survey to understand residents' perceptions of climate change and their readiness to tackle floods and droughts. Additionally, this task will use meta-analyses to evaluate environmental and climate justice data and develop water justice indices that quantify the disproportionate impact of water-related extremes on vulnerable communities.

The second task will create a comprehensive modeling framework using a catastrophe modeling approach to estimate the impacts of and recovery from extreme water events. This framework will incorporate several models, including a regional urban hydrologic model to simulate the rainfall and runoff process, a flood inundation model to calculate flood depths, a water distribution system model to simulate urban water supply, and a household-level agent-based model to simulate human responses to extreme water events. These models will be connected and simulate the bidirectional feedback between human society and the environment.

The third task focuses on collaborating with local stakeholders to address water justice issues and explore adaptation strategies, developing socioeconomic scenarios and decision-making thresholds, conducting climate stress tests on various water justice indices, and applying methods to quantify model uncertainties to enhance communication with stakeholders. Together, these tasks integrate scientific research with practical applications to help communities understand and adapt to climate change's impact on water resources.

The CRC will use the Lehigh Valley region in eastern Pennsylvania as a testing ground. The CRC aims to provide scientific insights to tackle local climate challenges through three main community engagement activities. The first engagement will involve collaboration with the three-city coalition of Allentown, Bethlehem, and Easton and addresses various issues such as sustainability and homelessness, including climate change impacts. The CRC will contribute scientific support for managing stormwater and urban flooding and planning for sudden droughts. Second, using the results from their research, the CRC will work with climate and environmental councils in the local government that address socioeconomic disparities, focusing specifically on flood and drought risks for vulnerable communities. Third, the CRC will host workshops in partnership with a nonprofit organization: Community Action Lehigh Valley. These workshops will involve vulnerable groups in discussions about their perceptions of climate change and possible actions to mitigate extreme water events. These sessions will also help the CRC develop scenarios that reflect community concerns and gather feedback to refine models.