

June 1, 2022-May 31, 2023



**CAROLINAS
CAP/RISA ANNUAL
PROGRESS REPORT**

Carolinas Collaborative on Climate, Health, and Equity (C3HE)

Building a Just Climate Future

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SECTION A: AWARD DETAILS

Team Name: Carolinas Collaborative on Climate, Health, and Equity (C3HE)

Performance Period: June 1, 2022- May 31, 2023

Grant Number: NA21OAR4310312

Team Members

Leadership Team

Dr. Kathie Dello, North Carolina State University (NCSU), Lead PI and Director of the North Carolina State Climate Office (NCSCO)

Dr. Louie Rivers, Environmental Protection Agency (EPA), Lead PI and Senior Social Science Advisor in the Office of Research and Development

Dr. Jennifer Runkle, North Carolina State University (NCSU), Lead PI and Environmental Epidemiologist at the North Carolina Institute of Climate Studies (NCICS)

Kalyn Rosenberg, North Carolina State University, Senior Program Manager of C3HE*

Co-PIs

Dr. Florence Anoruo, South Carolina State University (SCSU), Plant Physiologist/Ecologist/Environmentalist and faculty in the Department of Biology, Visiting Scientist at Brookhaven National Lab

Max Cawley, Museum of Life and Science, Program Manager for Public Engagement

Dr. Tonya Gerald-Goins, North Carolina Central University (NCCU), Associate Professor in the Department of Chemistry and Biochemistry

Dr. Geoffrey Habron, Furman University, Professor in the Department of Earth, Environmental and Sustainability Sciences

Dr. Jane Harrison, North Carolina State University (NCSU), Coastal Economics Specialist for the North Carolina Sea Grant (NCSG), Graduate Faculty in the College of Natural Resources

Dr. Miyuki Hino, University of North Carolina at Chapel Hill (UNC CH), Assistant Professor in the Department of City and Regional Planning, and Adjunct Assistant Professor in the Environment, Ecology, and Energy Program (E3P)

Dr. Natasha Malmin, Clemson University, Policy Scientist and Assistant Professor in the College of Behavioral, Social and Health Sciences

Dr. Caela O'Connell, University of North Carolina at Chapel Hill (UNC CH), Assistant Professor in the Department of Anthropology and joint faculty at the E3P. Internal Program Evaluator for C3HE.

Dr. Antonia Sebastian, University of North Carolina at Chapel Hill (UNC CH), Assistant Professor in the Department of Earth, Marine, and Environmental Science

Staff

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Dr. Rebecca Ward, NCSU, Assistant State Climatologist at the NCSCO

Trista Welch, NCSU/NCICS, Climate Adaptation Research Coordinator with the Eastern Band of Cherokee Indians*

Mike Winiski, Furman University, Director for Applied Sustainability Research at the Shi Institute*

Students

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Bevin Hardy, UNC CH, PhD Student

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Kaitlin Karaffa, NCSU, PhD Student*

Taylor Le Moal, Clemson University, PhD Student*

Max Lewin, UNC CH, Undergraduate Student*

Margot Midff, UNC CH, Undergraduate Student*

Hunter Quintal, UNC CH, PhD Student

Lily Raye, NCSU, PhD Student*

John Roper, Furman University, Undergraduate Student*

Manuel Valbuena Pena, NCSU, NCSG Intern*

*Individuals who joined the team within this past reporting period

Advisory Board

North Carolina

Deke Arndt, NOAA, Director of National Centers for Environmental Information

Neasha Graves, UNC Center for Public Engagement with Science Institute for the Environment, Environmental Health Outreach Manager

Bill Holman, The Conservation Fund, NC State Director

Stephanie Johannes, NC Clinicians for Climate Action, Founder & Director of Strategy

Mark Little, NC Growth, CREATE Executive Director

Dr. Amanda Martin, NC Office of Resilience and Recovery, Chief Resilience Officer

Will McDow, Environmental Defense Fund, Climate Resilient Coasts and Watersheds Director

Hudson Vaughn, Marian Cheeks Jackson Center, Interim Executive Director and Co-Founder

South Carolina

Ben Duncan, SC Office of Resilience, Chief Resilience Officer

Matthew Gorstein, SC Sea Grant Consortium, Coastal Economics Program Specialist

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Rob Merchant, Beaufort County Planning and Zoning Department, Director

Dale Threatt-Taylor, The Nature Conservancy, SC Executive Director

SECTION B: ACCOMPLISHMENTS

The Carolinas Collaborative on Climate, Health, and Equity (C3HE) is committed to understanding our changing climate and addressing the impacts in a just and equitable way. We work together with communities across the Carolinas to help predict and understand their exposure and vulnerability to climate threats, such as fire, flood, and heat. By integrating social science, physical science, and regional knowledge, the C3HE team and participating groups co-produce solutions that are tailored to meet unique local needs and priorities.

Focusing our efforts on frontline and at-risk populations, we strive to support communities that are disproportionately exposed to climate hazards and other compounding social inequities. During the previous reporting period, we identified a few key community partnerships including: the Eastern Band of Cherokee Indians (EBCI); Albemarle Regional Health Services (Northeastern North Carolina); the North Carolina Climate Justice Collective; and Greenville County, SC. This past year we focused on strengthening these collaborations and translating the plans created in year one into enhanced capacity and local action in year two, while also exploring new community partnerships.

Key accomplishments from this past year include:

- Working with EBCI Tribal leaders to inform and develop their Climate Action Plan;
- Sharing research and recommendations with coastal communities to help them monitor sunny day flooding and inform climate adaptation plans;
- Further developing a strong cohort of researchers across the Carolinas from existing agencies and universities, and building a team of students who are supporting each other as well as the valuable community-level work.



Leveraging NOAA and Other Climate Services

Our co-lead PI, Dr. Kathie Dello, is the Director of North Carolina State Climate Office (NCSCO) at NCSU, one of the largest and most productive State Climate Offices in the country. Her office is co-located with the National Weather Service in Raleigh and located on NCSU's Centennial Campus along with NOAA's North Carolina Sea Grant. The NCSCO collaborates closely with these entities to serve the state of North Carolina and reach a broad constituency. Co-PI Dr. Jane Harrison is a NC Sea Grant researcher. Co-lead PI Dr. Jennifer Runkle is co-located at the National Center for Environmental Information (NCEI) and the North Carolina Institute for Climate Studies (NCICS), a NOAA Cooperative Institute. These alliances and co-location allow us to leverage existing research opportunities, data, and products, such as the Environment & Climate Observation Network (ECONet). With this strong alignment of NOAA assets and climate services as our foundation, we are able to focus our CAP/RISA funding and work on helping communities develop, scale, and implement solutions. We can also reach communities that have not been previously served by other NOAA efforts.

Featured Accomplishment:

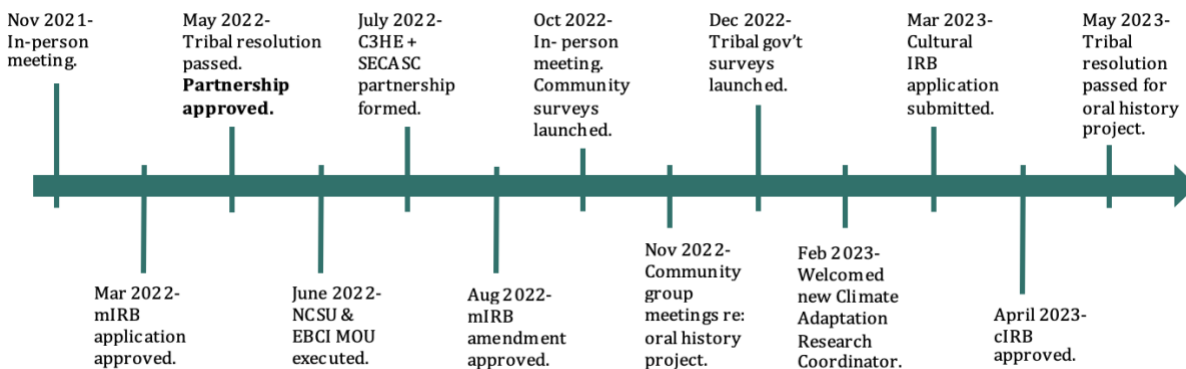
Eastern Band of Cherokee Indians (Western NC): *A five-year collaboration with the Division of Agriculture and Natural Resources of the Eastern Band of Cherokee Indians (EBCI) to integrate climate into all aspects of tribal governance*

Planning for the Next Seven Generations with the EBCI

This tribal-led community partnership integrates Traditional Ecological Knowledge from Tribal Government and community entities and technical climate, health, and social science expertise from the C3HE team.

The goals of our five-year partnership with the EBCI are to: 1) identify and prioritize climate and health hazards in collaboration with EBCI Tribal Government leaders and community members; 2) develop a Tribal Government Climate Action Plan to enhance tribal capacity to develop climate resilience solutions now and in the future.

In the past year, we made progress toward an EBCI Tribal Climate Action Plan through the following activities:



Translation of Climate Change in Cherokee - E-lo-hi-a(d)-ste-da-li-sgv-i: Over the past year, the team worked closely with native speakers to translate “climate change” into a Cherokee phrase with cultural value and importance, which better reflects and honors the relationship to the land. This phrase is E-lo-hi-a(d)-ste-da-li-sgv-i. Through conversations with the Principal Chief, government officials, and enrolled tribal citizens, we learned that there was a desire to describe the term “climate change” using the Cherokee language in order to reflect the traditional knowledge of a people who have lived with the land for a very long time. Because language is a direct representation of a peoples’ perception, knowledge, and relationship to the land, it became a priority to find meaning for this concept in the Cherokee language.

Oral Histories with Tribal Elders: We are recording oral histories to archive the richness of the Cherokee language as a direct expression of the Tribe’s traditional knowledge and connection to place. Documenting the important life stories of EBCI Tribal Elders required working through various levels of Tribal Government to receive the appropriate approvals. We received approval for the oral history collection and archival plan by the Tribal Cultural Institutional Review Board (cIRB) as well as the unanimous approval of the oral history project through a Tribal Council Resolution in May 2023. We have hired and started training a team that includes EBCI members to conduct the

interviews in Cherokee. The oral history interviews will include Tribal Elders and a multigenerational sample in collaboration with the Museum of Cherokee Indian (MCI) and the Kituwah Adult Language Program, both of which will be involved in the recruiting, interviewing, recording, and archiving process. The stories, perspectives, and words shared by the people participating in this project will directly influence and serve as an important foundation for the EBCI's Climate Action Plan. Tribal Elders are receiving compensation for their participation in this project.

Climate Risk Assessment Surveys: The team has conducted two surveys targeting (1) EBCI Tribal Government staff to understand climate concerns, how climate change is currently being considered in divisional/programmatic priorities, and potential barriers to achieving policy change; and (2) EBCI Tribal Community members to understand climate concerns, the importance of the issue of climate change, and valued cultural and community assets that might be impacted by climate change. Results will be incorporated into the Tribe's Climate Action Plan and inform tailored communication strategies to achieve tribal-wide participation and buy-in from all members.



Results from Tribal Government Staff Survey (n=233):

- 7 out of 10 government staff agree that Cherokee, NC is experiencing the effects of climate change now.
- 8 out of 10 government staff agree that Cherokee, NC will experience the effects of climate change.
- The top climate concerns are #1 wildfires, #2 drought, #3 flooding, and #4 extreme heat.
- 72% of government staff agreed that preparing to deal with the effects of climate change should be an important priority for the tribe.
- Only 4 out 10 agree that government staff are knowledgeable about the potential impacts of climate change.
- 47% of government staff agreed that there is a lack of climate information at decision-relevant scales.

Results from Tribal Community Member Survey (n=169):

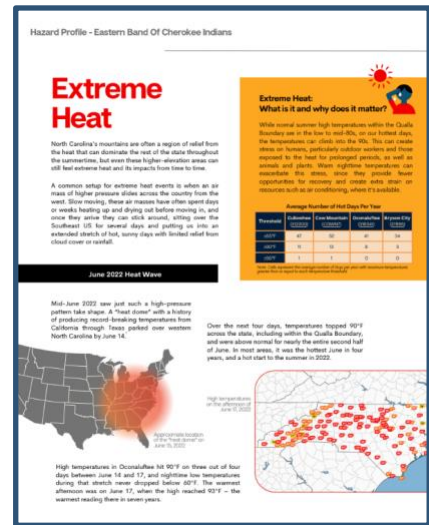
- 8 out of 10 respondents agree that Cherokee, NC is experiencing the effects of climate change now.
- 9 out of 10 agree that Cherokee, NC will experience the effects of climate change.
- The top climate concerns are #1 wildfire, #2 extreme heat, and #3 flooding.
- 3 out of 4 said that E-lo-hi-a(d)-ste-da-li-sgv-i was a personally important issue.
- More than 75% of participants believed that their community is not prepared for the impacts of climate change.
- 3 out of 4 believed that the tribe can act collectively to reduce the negative effects of E-lo-hi-a(d)-ste-da-li-sgv-i.
- More than half of the participants believe that there are adequate resources to address climate risk in Cherokee.
- The majority of community members believe that now is the time to take strong action on climate change.

Increasing Community Capacity: We welcomed Ms. Trista Welch to the C3HE team in early 2023. Ms. Welch is an EBCI member and our new Climate Adaptation Research Coordinator and liaison. We were able to onboard her into a paid position at NCSU in partnership with the Department of Interior Southeast Climate Adaptation Science Center (SECASC). The position allows us to keep resources in the community, rely on a trusted and known individual to further resilience goals, and share costs across two federally-funded climate centers with complementing missions and planned work with the EBCI. In a short time, Ms. Welch has helped to increase our team’s capacity to make on the ground connections and coordinate with community clubs and other local organizations.

The NCSCO will be installing a new North Carolina ECONet weather station in Cherokee, NC as a complement for existing air quality monitoring. These data will enhance the tribe’s capacity to measure air quality by providing a means to also capture weather and climate data, and allow them to pursue external funding to alleviate air quality concerns. This station will be integrated into the NCSCO’s full suite of data plotting and access tools.

Organizing and Distributing Information: Our team, supported by the NCSCO, worked with the EBCI Division of Agriculture and Natural Resources to develop two-page profiles on historical and projected changes in drought, extreme heat, extreme precipitation, and wildfires for Cherokee and the Qualla Boundary. These will be integral to developing a Climate Action Plan in the next phase of work. These profiles will be also used to start the conversation with community members about climate hazards, leading to the development of a personal solutions guidebook.

This year we explored existing examples of tribal climate adaptation plans and identified a framework to build and inform the EBCI Climate Action Plan during a March 2023 meeting between the C3HE team and EBCI tribal government staff.



“As we continue to work through the objectives of the project over the couple of years, I know that we are forging a last[ing] partnership that is truly built upon mutual understanding and consideration for working within a community such as ours. The NCSU team and its network can continue to find willing partners from the Division of Agriculture and Natural Resources.”

- Joseph Owle, Secretary of Agriculture and Natural Resources,
Eastern Band of Cherokee Indians

Project Updates

Enhancing Climate Fluency and Health Equity with Albemarle Regional Health Services (ARHS)

Since the fall of 2021, the C3HE team has been working with ARHS leadership to assess the needs of the community, identify linkages between climate and health stressors (e.g., harmful algal blooms, heat, and drought), and develop a communication and response plan. Efforts this year have been focused on the following initiatives:

- Producing and distributing educational materials on harmful algal blooms in order to increase public awareness and promote public reporting of possible algal bloom sightings;
- Designing and distributing a climate fluency survey among ARHS staff to understand how public health leaders are currently thinking about and incorporating climate change into their work. We will use these survey results to inform a train-the-trainer session this fall so that ARHS staff can serve as trusted messengers to doctors, pharmacists, and other public health officials;
- Enhancing workforce development in rural eastern North Carolina. We created weather/climate education kits to increase capacity of local K-12 schools to teach weather and climate and to support regional climate literacy;
- Distributing of 25 precipitation gauges to augment environmental monitoring efforts, such as monitoring of mosquito populations, and to engage community members in making precipitation observations. These observers are reporting to the Community Collaborative Rain, Hail, and Snow Network (CoCoRaHS) and have increased the density of observations in rural Northeastern North Carolina.



Partnership with the North Carolina Climate Justice Collective (NCCJC)

The C3HE team has benefited from the teaching and guidance of the NCCJC, a group of climate justice experts leading the way on community climate resilience and calling for a transition to a more just society. We are partnering with the NCCJC in their efforts to address the root causes of climate change in communities across North Carolina.

We co-developed a 30-item disaster response and preparedness survey with NCCJC staff to assess strengths and vulnerabilities in local communities. Results will enhance the capacity of the regional Resilience Organizing Hubs to build skills to help local residents prepare for and respond to climate disaster. The NCCJC trained over 20 community volunteers to canvas neighborhoods and survey residents in four resiliency organizing hubs across central and eastern North Carolina and collected over 140 responses from local community members.

The NCCJC team has also provided crucial expertise and training to help the C3HE team integrate climate justice principles into all aspects of our work and to help inform the development of a

justice, equity, diversity, and inclusion (JEDI) action plan. C3HE investigators, staff, and students participated in a half-day training led by the NCCJC on how to incorporate JEDI principles in academic-community research partnerships.

Sustainability Activities in Greenville County, SC (Upstate SC)

The C3HE team, in collaboration with the Shi Institute for Sustainable Communities at Furman University, have been working with community members and local stakeholders to enhance climate resilience in Greenville County, SC. Because at-risk communities often share a hazard geography with more affluent communities, we are working to enhance coordination between these communities as towns and municipalities in Greenville County are developing and implementing local sustainability plans.

Key goals of this partnership include:

- Integrating local knowledge, priorities, and perspectives to inform decision making processes on resilience, climate and environmental change;
- Understanding connections and intersections between distinct communities in Greenville County to better recognize how resilience decisions and environmental change simultaneously affect affluent and at-risk communities;
- Connecting and engaging people between more and less affluent communities that share a similar geography to build more visibility and strengthen motivation for action.

A team of undergraduate students led by co-PI Dr. Geoffrey Habron at Furman University conducted research with 13 predominantly Black Special Emphasis Neighborhoods (SEN) to identify climate risks and concerns. Results identified urban heat, health disparities, gaps in workforce development, and a lack of tree canopy as leading community concerns.



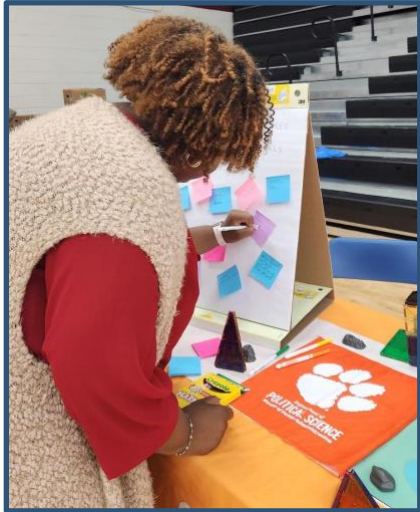
TreesUpstate, an existing community partner, requested support in expanding this work to Spartanburg, SC, as the City of Spartanburg recently published a Comprehensive Plan outlining a growth and conservation framework. Students worked closely with TreesUpstate to identify neighborhoods of interest to inform tree planting efforts to equitably address urban heat islands.

This upcoming year, the C3HE team plans to conduct focus groups with these neighborhoods, and will expand the project to reach more Hispanic and Latinx communities. The focus groups aim to understand how residents across environmental, geographical, economic and political power geographies across Greenville County conceptualize environmental change, equity, and health in their communities. Examining climate and resilience priorities across jurisdictional boundaries will allow disparate communities to find common ground and work towards mutual benefit.

New Focus and Partnerships

Palmetto Resilience Cluster

Co-PI Dr. Natasha Malmin has been leading preliminary work to identify the impact of recurrent disasters on critical infrastructure in frontline communities in an 11-county region within eastern South Carolina most impacted by repeat flooding and hurricanes. Those counties are: Berkeley,



Charleston, Darlington, Dillon, Florence, Georgetown, Horry, Lee, Marion, Marlboro, Williamsburg. The goals are to: 1) understand the role of existing policies in mitigating impacts and shortening recovery timelines; and to 2) develop policy toolkits which facilitate rapid assessment and assistance after disasters.

The C3HE team has also been building partnerships with nonprofits operating throughout eastern SC, including: Williamsburg Health Extension Program; Williamsburg 4 – H program; Waccamaw Economic Opportunity Council; CMD Food Bank; and the Cassandra C. Rush African American Museum. This work aims to strengthen existing community based programs, integrating disaster-related information into ongoing outreach efforts, with the potential to develop guidebooks to support Extension Programming.

Compounding Disasters in Ocracoke, NC

Ocracoke was devastated by compounding disasters: Hurricane Dorian in the fall of 2019 and the onset of the COVID-19 pandemic in the spring of 2020. In the summer of 2022, Co-PI Dr. Caela O’Connell started an effort to conduct a rapid appraisal on impacts to Ocracoke businesses and community resilience. Preliminary data indicate that the main impacts from these events include: a steep decline in availability of affordable housing; loss of medical professionals; increased substance abuse and mental health issues; increased labor costs; and decreased labor availability.

The C3HE team will assess climate adaptation issues as perceived by community stakeholders and identified through coastal data, including issues related to accessing health care and affordable, safe housing. In the first phase, the research team will explore cultural processes, risk perception, unmet community needs, and outline steps for resilience-based action among year-round residents (as opposed to seasonal occupants). This work will include examining compound disasters, cultural and environmental elements that define coastal resilience, and interdependencies between the island and mainland. Ultimately, data collected can be used to inform future decisions regarding housing construction, health care needs and staffing, school planning, and climate adaptation planning.



Research Highlights

Climate Change and Onsite Wastewater Treatment Systems (OWTS) in the Coastal Carolinas

Storm surges and heavy precipitation can lead to malfunction of conventional septic systems in coastal North Carolina.

Co-PI Dr. Jane Harrison led an interdisciplinary research team to evaluate existing onsite wastewater technologies under multiple climate conditions in the coastal Carolinas. Findings show that septic systems can malfunction following storms and heavy precipitation. Based on study results, recommendations include: incorporation of weather and climate risk in OWTS development; maintenance protocols to ensure effective treatment of bacteria, nitrogen, and phosphorus; and improved communication structure between regulators and homeowners.

Results were compiled in a public report and a peer-reviewed publication in the journal *Weather, Climate and Society*. Key recommendations were included in the Town of Nags Head updated decentralized wastewater plan, which was approved in spring 2022. Findings were also disseminated to OWTS operators/installers and health officials. Communities such as Folly Beach, SC, are using results to inform climate adaptation activities, and environmental organizations are relying on the recommendations to steer advocacy efforts.

Vorhees, L., Harrison, J., O'Driscoll, M., Humphrey, C., & Bowden, J. (2022). Climate change and onsite wastewater treatment systems in the Coastal Carolinas: Perspectives from wastewater managers. *Weather, Climate, and Society*, 14(4), 1287–1305. <https://doi.org/10.1175/wcas-d-21-0192.1>

Data from the Drain: A Sensor Framework that Captures Multiple Drivers of Chronic Coastal Floods

25% of flooding in Beaufort, NC was driven by land-based sources (rain + tide), illustrating the need to address the multiple compounding sources of flooding.

Co-PI Dr. Miyuki Hino, together with a team of researchers from UNC Chapel Hill and NCSU, released a new study, *Data from the Drain: A Sensor Framework That Captures Multiple Drivers of Chronic Coastal Floods*. Over the 5-month study period, 25% of the flooding in coastal areas was driven by land-based sources, illustrating the need to address the multiple compounding sources of flooding.

The Sunny Day Flooding Project presents a sensor framework, linked to a publicly accessible web app, to measure flood conditions and share the information. Results have been presented to Town Councils in Carolina Beach and Beaufort and shared with local officials in Carolina Beach, Beaufort, and New Bern.

Gold, A., Anarde, K., Grimley, L., Neve, R., Srebnik, E. R., Thelen, T., et al. (2023). Data from the drain: A sensor framework that captures multiple drivers of chronic coastal floods. *Water Resources Research*, 59, e2022WR032392. <https://doi.org/10.1029/2022WR032392>

Environmental Justice in Disaster Recovery: Recognition of the Latinx Community by Nonprofit Leaders

Disaster response efforts can worsen inequity, but this can be avoided through improved processes and acknowledgement of disadvantaged communities.

Co-lead PI Dr. Louie Rivers contributed to a study that examines how nonprofit organization leaders identify and respond to the needs of disadvantaged populations during disaster recovery efforts. Qualitative research was conducted with 19 representatives of nonprofit organizations in Wilmington, NC who participated in response activities following the occurrence of Hurricane Florence in 2018. This study focused on the recognition of and support provided to the Latinx community, an expanding population in Wilmington.

Results from semi-structured interviews revealed a range in the level of acknowledgement of the unique needs of the Latinx community. While the manner in which each organization developed and expressed their recognition of the Latinx community varied, the findings illustrate that nonprofit leaders are interested in promoting just outcomes. Having an in-depth understanding of disadvantaged communities, such as the Latinx community, is vital in designing disaster response and recovery policies, procedures, and programs. Recognition of the distinct situation of various populations, especially those most at risk, can help design tailored responses to environmental hazards, fostering more equitable outcomes.

Vilá, O., Cutts, B., Knollenberg, W., & Rivers, L. (2023). Environmental justice in disaster recovery: Recognition of the Latinx community by nonprofit leaders. *Climate Risk Management, 40*, 100502. <https://doi.org/10.1016/j.crm.2023.100502>

Growing Safely or Building Risk? Floodplain Management in North Carolina

In North Carolina, for every property removed through buyouts from 1996 to 2017, more than 10 new residences were built in floodplains.

Co-PI Dr. Miyuki Hino, along with Dr. Toni Sebastian, worked with a team to understand the relationship between flood risk management effort and development outcomes. Limiting housing and infrastructure in flood-prone places has long been recognized as critical to managing long-term risk. However, due to the difficulty of tracking development at small spatial scales, little empirical research has been conducted to explain differences between communities' floodplain development patterns. They analyzed new construction across 5 million parcels in the state of North Carolina. At the community level, indicators of flood risk management effort (participation in the Community Rating System and use of buyouts) did not consistently align with floodplain development outcomes. Although we did not capture the full range of flood risk mitigation practices, results indicate that local development policies often run counter to efforts to limit long-term risk.

Land use planning and floodplain management have the potential to play a larger role in flood risk mitigation. Modifying federal programs to more strongly disincentivize floodplain development could enhance local regulation and minimize future flood exposure. Given extensive undeveloped floodplain land and projected climate change, additional effort to manage development is needed to limit increases in flood risk.

Hino, M., BenDor, T. K., Branham, J., Kaza, N., Sebastian, A., & Sweeney, S. (2023). Growing Safely or Building Risk? *Journal of the American Planning Association*, 1–13. <https://doi.org/10.1080/01944363.2022.2141821>

Outreach and Engagement

Engaging with the general public and connecting with communities across the Carolinas is core to our mission and critical to our program's success.

In order to increase our program visibility, we have updated our program website, now available at www.carolinascap.com. Our website includes general information on our mission, our team, and publications. Through website accessibility audits, we have identified and implemented design changes to improve the user experience. We plan to expand our website to include more resources and tools, with the goal to function as a central hub for individuals and organizations interested in connecting with C3HE. Additional information on engagement, outreach, and media will be made available on our website.

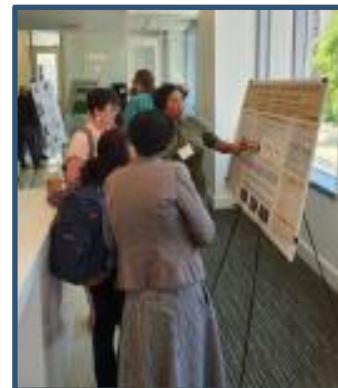
We have also created a [Twitter account](#), @Carolinas_CAP, to share public updates on our work.



Members of the C3HE team presented, facilitated, and/or participated in leadership roles in over 50 events, workshops, conferences and exhibits during the last reporting cycle.

Event, Workshops, and Conference Highlights

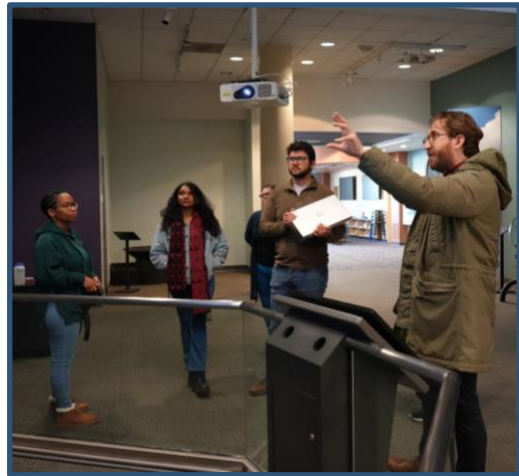
- "Financial Risks and Equitable Resilience Implications arising from Residential Flood Damages in Eastern North Carolina Communities", Atlanta, GA. June 5-8, 2022 (Co-PI Dr. Sebastian)
- "Understanding Human-Environment Relationships through Crisis *for* Change", University Day Keynote Speaker on C3HE work at University of North Carolina at Chapel Hill, October 12, 2022 (Co-PI Dr. O'Connell)
- "Tipping Points: Onsite wastewater treatment and climate change" Workshop for South Carolina environmental planners, December 14, 2022 (Co-PI Dr. Harrison)
- White House Forum on Community and Campus-scale Climate Solutions, Washington DC, March 2023 (Co-lead PI Dr. Dello)
- Smoke modeling training with Eastern Band of Cherokee Indians and US Forest Service, Asheville, NC, March 2023 (Co-lead PI Dr. Runkle)
- NC-Food, Energy, and Water (FEW) Education Invited Workshop, May 10-12 2023 (Co-PI Dr. Gerald Goins)



- Climate Documentary Screening at the Museum of Life and Science in partnership with PBS NC's State of Change, including one about C3HE's heat work, May 20, 2023 (Co-PI Cawley and Co-lead PI Dr. Dello)
- "Climate Impacts on the Health of Pregnant and Child Populations", NIEHS Epidemiology Branch and Climate Change Group Seminar series virtual speaker, May 22, 2023 (Co-lead PI Dr. Runkle)

Exhibits and Ongoing Engagement

- Imagine Durham 2100: Public exhibit and humanities project on climate, health, and arts, co-produced between C3HE and the Hayti Heritage Center in Durham, NC during January through May 2023. Durham Title 1 public school students participated in the curation and professional training on inductive coding for social science to code all art pieces. Work will be published in FY24. (Co-PIs Cawley and Dr. Sebastian)
- Searching for Evidence of Change: Decision-Making in a Changing Climate in Eastern NC- analysis work on oral history archive dating into the 1960s in Eastern NC, looking for evidence of climatic events (hurricanes, freezing, flooding, sea level rise) and community decision-making. This work will be exhibited at Core Sound Waterfowl Museum in the RISING exhibition and at Museum of Life and Science in the Climate and Sustainability Gallery in FY24. (Co-PI Cawley)
- HeatWave Exhibition: Museum of Life and Science (MLS) created and exhibited a temporary exhibition on participatory climate action and climate justice on extreme heat in Durham called HeatWave! Timing and tracking shows around 8,000 people used and participated in the exhibit while at MLS. (Co-PI Cawley)



Featured Student Engagement

Sea Grant Undergraduate Internship Program

In 2022, 85 undergraduate interns and 27 Sea Grant programs participated in an internship program focused on research and outreach projects on healthy coastal ecosystems, sustainable fisheries and aquaculture, resilient communities and economies, and environmental literacy and workforce development. Topics included coastal tourism, watershed education, and fisheries biology. Students were mentored by Sea Grant professionals, Sea Grant funded researchers, coastal partners, and Knauss Fellows. C3HE funded two undergraduate interns supervised by NC Sea Grant. These interns research climate justice considerations for local municipal policy.

C3HE Student Summer Experience (August 1-4, 2022)

Several C3HE members planned and implemented a pilot student summer experience for undergraduate students from Furman, NCSU, NCCU, and SCSU. Students visited campuses and sites managed by members of the C3HE team, including NCCU. Visiting faculty, staff, and students were greeted by the Dean of the NCCU College of Health and Sciences and met the Chair and the administrative assistant of Co-PI Dr. Tonya Gerald-Goins' home department.

Visitors were also introduced to one of the Food, Energy and Water Learning Module workbooks (FEWLM), "Exploring Scientific Inquiry and Mathematical Thinking with Skittles Workbook", created by Drs. Spence, Gerald-Goins, and Goins. FEWLM is an effort by African American STEM faculty to create high-quality, out of school learning experiences for "at-risk" underrepresented minority (URM) 3rd through 8th grade students less competitive in STEM. The curriculum is based on Next Generation Science Standards, with a system thinking approach that provides hands-on, self-driven and team-building activities with a goal to increase scientific exposure and encourage more "at risk" URM to enter and remain in the STEM pipeline.



Faculty and student participants also visited the Hayti Heritage Center to learn some of the history of Durham's Black Wall Street and about the Hayti Heritage Center's involvement in justice, equity, diversity, and inclusion (JEDI) initiatives.

Through evaluation surveys, students unanimously reported increased understanding of: 1) the intersection of equity and climate change; and 2) the potential health impacts of climate change. Students also indicated a deeper and more nuanced appreciation for the holism of a transdisciplinary research approach. Results also revealed that some students' future course selection and career trajectory may be influenced by their participation in this experience.

C3HE Multi-Hazards Graduate Student Cohort

As part of training the next generation of climate adaptation and resilience researchers, our graduate students have formed a multi-hazards independent student cohort. The students span three institutions: NCSU, UNC Chapel Hill, and Clemson University. They are in all stages of their graduate careers. The students meet monthly without the PIs and discuss research, prepare and practice conference talks, and work on professional development.

Each student represents some part of our larger proposal, coalescing into a cohort that is learning more about how compound hazards in the Carolinas are affecting frontline communities. Building this community has been especially helpful for our students post-Covid; students at UNC system campuses have reported feelings of isolation and loss of community.

Challenges

In general, the following challenges have emerged as consistent themes across program initiatives:

- **Compensating Partners and Participants:** The communities that are harmed first and worst by climate change often lack institutional capacity to participate in lengthy and intensive co-production efforts. We are trying to compensate community members for their time, but often run into obstacles put into place by NOAA and NCSU.
- **Paying for Research Incentives:** Offering research incentives is a standard practice in social science research. In this grant, it is hindered by a NCSU policy that PIs or staff must front the money for incentives from their personal funds and not use a university credit card or a direct bill to the grant, despite budgeting for these incentives during the proposal.
- **Aligning Schedules among Team Members:** Coordinating with colleagues is vital for advancing collaborative projects. Scheduling across multiple institutions, especially between research-intensive Research 1 universities (e.g., NCSU, UNC Chapel Hill, and Clemson) and mentoring and teaching-heavy HBCUs (e.g., SCSU and NCCU) can be an arduous process, sometimes limiting the ability of all team member to participate in projects equally.
- **Mitigating Societal Factors:** The impact of community stressors, such as lingering effects from the Covid-19 pandemic and industry loss, influence project timelines and affect individual team members and partners in assorted ways.

Next Steps

Compounding Heat and Flood Hazards in Raleigh and Durham, NC

PhD student Quintal, in collaboration with PIs Dr. Sebastian, Dr. Dello, and Cawley, is assessing when and where extreme heat and flood have sequentially occurred, evaluating whether the probability of their co-occurrence has changed over recent decades, and disseminating results through community partnerships with the intention to inform adaptation and mitigation efforts. Initial results show that flooding and heatwave hotspots in Durham, NC are associated with high building densities. Historically redlined neighborhoods experience both hazards.

We will also replicate this effort in Raleigh, NC. PhD student Karaffa is doing a summer internship with the City of Raleigh to implement storm water infrastructure to help mitigate flood and heat hazards in the city, especially in lower income neighborhoods.

Local and County Heat Wave Protocol Template Development

We are developing a template for local and county governments for heat wave management protocols, messaging templates in English and Spanish, accompanying instructional documents, and hosting a workshop in July 2023 to guide users through the adoption of the template protocol and receive feedback on the deliverables.

All documents will be designed for use by local governments in North Carolina. The NCSCO will also follow-up with workshop participants on evaluating use and efficacy of the protocol. The NCSCO will work with the participants and project teams to refine the protocols based on the feedback.

This is an effort of the NCSCO and C3HE, with participation from the North Carolina Office of Recovery and Resiliency (NCORR), NC Department of Health and Human Services (DHHS), the Duke University Heat Policy Innovation Hub, and the Chatham County Health Department. This planning team will meet regularly throughout the project to guide, review, and provide feedback on the deliverables. The protocols will formally launch in 2024, with impact-based heat wave threshold definitions.

Advancing State-Level Policies on Sustainable and Climate-Resilient Health Care Systems

Carolina Advocates for Climate, Health, and Equity (CACHE), formerly known as the North Carolina Clinicians for Climate Action, is a new health professional-led organization in North Carolina that educates health professionals, health system leadership, and the public on the health impacts of climate change. CACHE activates health professionals to use their trusted voices to advocate for climate solutions that promote health and equity across the state. This group has a particular focus on addressing the significant contribution of the health sector to climate change and fossil fuel use, and the associated harms to public health.

In March, the Department of Health and Human Services (HHS) Office of Climate Change and Health Equity (OCCHE) reopened the Health Sector Climate Pledge. This year C3HE partnered with the CACHE to engage health professionals, health system leadership, and community leaders in urging health system decarbonization and climate resilience. Planned summer activities include: 1) hosting three events to raise awareness in health system leadership on Inflation Reduction Act (IRA)-related opportunities available to the health sector to address climate change; 2) hosting three community events in partnership with community-based organizations; and 3) scheduling policy briefing meetings with local government leaders in cities home to NC's largest health systems. In May 2023, CACHE was awarded funds from the Environmental Defense Fund's Summer of Action grant to carry out this important work.

Broadening our Work in South Carolina

Following our framework of community selection developed in year one, we will be proactively working to expand our partnerships throughout the state of South Carolina. Our team will be scoping out opportunities for collaborating with frontline communities specifically considering factors of equity, probability of exposure to climate hazards, and the possibility of intervention. We will examine where and how the expertise on the C3HE team can appropriately and effectively advance climate resilience and health equity. We will facilitate scoping meetings to evaluate the possibility of partnership with identified communities.

Undergraduate Student Engagement

A subcommittee of the C3HE will plan and host an event for undergraduate students, primarily from Historically Black Colleges and Universities (HBCUs). Through various activities, we will introduce students to the diversity of careers in climate resilience. This experience will illustrate a path from undergraduate to graduate school and will provide a networking opportunity among students. Based on the evaluation results of last year's undergraduate student event, recruitment efforts will be focused on students in their first year of college to offer them greater options in changing or narrowing their study trajectories.

SECTION C: IMPACT

Evaluation

Co-PI Dr. Caela O'Connell, the internal program evaluator, is conducting generalized evaluation through annual conversations with team members on their expectations, realizations, setbacks, hopes, change, growth, and concerns for the team, personally, and for any projects they are involved with. Dr. O'Connell is also performing a systematic review of published community based participatory research studies that involve environmental and climate research in order to inform the drafting of an open-access protocol that can be used by interdisciplinary teams that are hoping to partner with or involve community members in their work. This systematic review will also be published as a standalone article.

Evidence of Societal Impact

Distribution of Knowledge to Public Leaders

Recommendations from Co-PI Dr. Jane Harrison's research were included in the Town of Nags Head updated decentralized wastewater plan, which was approved in spring 2022. They were also disseminated to OWTS operators/installers and health officials. Communities like Folly Beach, SC are using results to inform climate adaptation activities, and environmental organizations like the South Carolina Environmental Law Project are relying on the recommendations to steer advocacy efforts.

Community Level Implementation of New Technology and Tools

Partner communities, such as the emergency management in Carolina Beach, use the Sunny Day Flooding web app cameras to determine when roadways need to be closed, and public works in New Bern looks at water levels to assess wind-driven flooding.

Testimonial

"The Eastern Band of Cherokee Indians (EBCI) partnership with North Carolina State University (NCSU) for the NOAA RISA grant was an opportunity of the right time and right people/organization. The EBCI has a strategic priority of developing a one-hundred-year plan for the preservation and conservation of our natural resources through the development of a climate action plan. When Dr. Jen Runkle approached our team about the funding opportunity, we completed our due diligence and determined that this partnership would be the appropriate partnership to form to meet our mutual goals and objectives...

Throughout the implementation of the project, the team that Dr. Runkle has assembled has been exceptional both in professional acumen and cultural competence. They have been receptive to our recommendations and guidance for interacting with our tribal government and tribal community members. This is not a community that academics can just walk into and say they have a solution to our problems. They have been thoughtful and methodical by collaborating to create unique tools to meet our objectives in a timely manner. Dr. Runkle routinely goes above and beyond to hear our needs and ideas, and then work extra hard to lead and assist where available on various projects."

- **Joseph Owle, Secretary of Agriculture and Natural Resources, EBCI**

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