CAROLINAS INTEGRATED SCIENCES & ASSESSMENTS

PROJECT PROGRESS REPORT: 1 JUNE 2016 - 31 MAY 2017

NOAA AWARD NA16OAR4310163

CISA
Carolinas Integrated Sciences and Assessments
A NOAA RISA TEAM

RISA
Regional Integrated Sciences and Assessments

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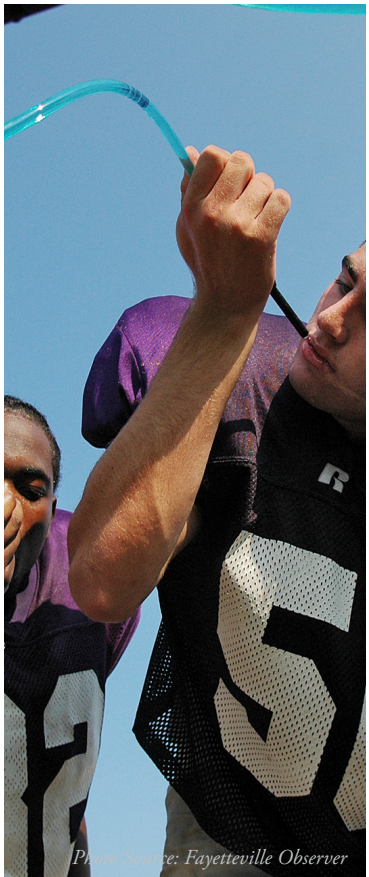
Photo Source: Fayetteville Observer

MEET THE TEAM

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The CISA Program

Established in 2003, the Carolinas Integrated Sciences & Assessments (CISA) is 1 of 10 NOAA Regional Integrated Sciences & Assessments (RISA) teams. RISAs are interdisciplinary research teams that work to expand and build the nation's capacity to prepare for and adapt to climate impacts by addressing science questions facing decision makers. A key component of the RISA program is working at the regional level to address relevant and timely climate issues of concern.

The CISA team works to increase resilience in the Carolinas through applied climate research in collaboration with a wide range of stakeholders. CISA has established long-term partnerships with federal, state, and local government agencies, resource managers, non-governmental organizations, and the private sector. Working at the intersection of climate with water, coasts, and health, CISA provides decision makers with tailored information that can be integrated with existing management and planning processes. As a trusted source of climate information for the Carolinas, CISA supports state and local climate adaptation through project-specific engagements as well as broader communications and outreach efforts and materials. Convening the regional network of climate adaptation practitioners at the bi-annual Carolinas Climate Resilience Conference has become a hallmark of the program.

CISA
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2016-2017 CAROLINAS WEATHER + CLIMATE EVENTS

In addition to projects outlined in our proposal, the CISA team works to respond to stakeholder and decision maker information needs as they arise, which are often prompted by specific weather and climate events in the region. Below are a few of these notable events from the past year.

SPRING FREEZE

March 15-17, 2017: A mild winter and warm early spring temperatures caused an early bloom for SC peaches and blueberries. Several nights with temperatures below freezing killed a majority of these crops.

KING TIDES

King Tides, a non-scientific term to describe the highest seasonal tides, are a regular occurrence along the Carolinas' coastline, but can cause major flooding issues in coastal communities. There were 65 days between June 2016 and May 2017 where King Tides were recorded in the Carolinas.

Photo Credit: Ashley Ward

HIGH HEAT DAYS

Temperatures exceeded 100 degrees F in Columbia, SC 21 times in 2016. Charleston, SC recorded the hottest July on record. Raleigh, NC had the 3rd warmest summer in the past 130 years.

DROUGHT

Drought conditions persisted to some degree throughout the Carolinas over the past year. The most severe drought occurred in November 2016, when exceptional drought (D4) conditions were observed in the western Carolinas.

FALL WILDFIRES

October 23- December 5, 2016: 34+ wildfires burned over 60,000 acres in the fall of 2016, mostly in the western Carolinas, where drought conditions were the most severe.

Photo Source: Fayetteville Observer

HURRICANE MATTHEW

Matthew made landfall on the South Carolina coast on October 8, 2016 as a Category 1 hurricane with 75 mph winds. Between 10-17 inches of rain fell from Savannah, GA through eastern NC. Heavy rains forced rivers in SC and NC above major flood stage. The storm caused severe beach erosion, thousands of downed trees, and damage to roads, bridges, homes, and businesses.

EXPANDING OUR REACH

Providing Climate Information & Services Through New Partnerships

Photo Source: Fayetteville Observer

Reducing Health Vulnerabilities to Climate Impacts in North Carolina

CISA is engaging new stakeholder communities as we expand our work to support public health decision making. An evolving partnership with the University of North Carolina's Institute of the Environment has created new opportunities for collaboration around the Heat Health Vulnerability Tool and Convergence website. The Institute engages with public health departments state-wide in North Carolina on a variety of issues related to impacts from climate extremes. This partnership has broadened our reach outside the Sandhills region (the initial focus of the heat-health work) and into communities in other regions of the state. This will allow a more comprehensive approach to our work, which is designed to address a variety of climate-health interactions across the state. Other network connections have led to engagement with the North Carolina Tribal Council and a presentation of the heat-health efforts to the North Carolina American Indian Health Board.

Customizing Climate Information for Regional Planners

The Central Midlands Council of Governments (CMCOG), which covers a four county region in central South Carolina, approached CISA to request information about regional climate and impacts to water quality and supply. These regional planners are interested in facilitating conversations with CMCOG board members and elected officials about future climate conditions and impacts, especially for planning processes and decisions that have long-term implications, such as water and sewer infrastructure. CISA is using information from the Carolinas Precipitation Patterns and Probabilities Atlas and other downscaled climate projections research to develop tailored materials. A primary goal of this project is to produce tailored information and materials that the CMCOG can use to effectively communicate the most relevant aspects of climate science to those involved in regional planning.

Inclusive Climate Adaptation and Resilience Building

A pre-conference workshop at the 2016 Carolinas Climate Resilience Conference brought together strong interest in how diverse communities can prepare for and respond to climate impacts and future climate change. Understanding how climate-related concerns relate to and compound many other stressors and challenges these communities face was a primary goal of the workshop. The discussion led to the creation of a small network of individuals who are actively seeking to advance this conversation through the establishment of the Carolinas Climate Action Faith Leaders Network. With travel support from CISA, this group conducted a similar session at the 2017 National Adaptation Forum in order to connect to the national network.

Leveraging the Community Rating System for Coastal Climate Adaptation

CISA is working to identify and refine ways in which extension and communications staff can effectively support local communities seeking to participate in the National Flood Insurance Program's Community Rating System (CRS) or increase their current CRS scores while also enhancing resilience through selected CRS practices. The South Carolina Department of Environment and Health Control's Office of Ocean and Coastal Resource Management (OCRM) recently formed a CRS Users Group, with the specific intention of aligning beach front communities' Local Comprehensive Beachfront Management Plans with CRS to garner more support for both and capitalize on ways to earn points for the CRS. CISA is participating in this users group to identify opportunities to collaborate, with the intention of expanding any efforts beyond just the beach front communities.

Launching New Partnerships with Virginia Sea Grant

In order to share lessons learned and approaches to coastal climate adaptation and sea level rise challenges, CISA is collaborating with Virginia Sea Grant (VASG) and the seven universities in the VASG Charter. Their combination of scientific expertise and experience in the Hampton Roads area will help to advance coastal adaptation in the Carolinas as well. VASG traveled to Charlotte for the 2016 Carolinas Climate Resilience Conference, organizing a session to showcase the Hampton Roads Sea Level Rise and Resilience Intergovernmental Planning Project. CISA partners have attended events in Virginia to share lessons learned from the Carolinas including the Hampton Roads Adaptation Forum and the Blue Planet Forum on Resilience. VASG is also working with CISA and our colleagues at the SC Sea Grant Consortium to organize the Hampton Roads and Charleston Coastal Resilience Knowledge Exchange, during which planners, emergency managers, and other practitioners from both communities will convene in Charleston, SC for two days of information sharing and facilitated dialogue.

Photo Credit: Chandler Green

THE CISA FOOTPRINT

Evaluating Our Impact In The Region

Evaluation of the CISA program measures how effective we are in achieving our goal of supporting and fostering the capacity of the Carolinas to respond to and prepare for climate variability and change and associated impacts on the region's resources and communities. We work to achieve this goal through four key program elements:

- Research to advance understanding of climate and its impacts in the Carolinas;
- Collaborations to support the implementation of climate adaptation strategies;
- Providing innovative decision support services; and,
- Outreach and engagements to foster climate information networks throughout the region.

Throughout the life of the CISA program, we have adopted various approaches to monitor and evaluate our impact, including both quantitative metrics (see the CISA By the Numbers infographic) and qualitative analysis of individual projects and the program as a whole.

Individual projects, such as the Heat Health Vulnerability Tool and Convergence website, the citizen science condition monitoring project, and the Carolinas Precipitation Patterns and Probabilities Atlas integrate evaluation questions and metrics throughout research and engagement activities. Direct stakeholder feedback helps us to understand what types of information are most important and how stakeholders intend to use the information, which in turn informs resource and tool development through an iterative process. In addition, evaluation requests are circulated to all workshop and conference attendees to improve future events and assess which content is most relevant and useful.

A program-wide evaluation is scheduled for Year 2 of the current grant (2016 – 2021). Based on feedback from our advisory committee and RISA office, the format will be similar to the 2014 program evaluation in which three external reviewers considered progress reports and conducted feedback interviews with CISA team members, collaborators, advisory committee members, and stakeholders. Reviewers evaluated work-to-date to highlight our strengths and recommend areas where we might be able to build more capacity. The next evaluation will be held in conjunction with the 2018 Carolinas Climate Resilience Conference so that evaluators will have ample opportunities to interact directly with the CISA team, partners, and stakeholders.

We also look to our Advisory Committee to help us stay connected to other work in the region, keep a finger on the pulse of stakeholder needs, and advise on the balance of efforts and impact. We hold an in-person meeting annually and provide regular communications and program updates through monthly full team call minutes and quarterly newsletters.

BY THE NUMBERS

2 MASTER'S THESES

3 JOURNAL ARTICLES
EDITED BOOK CHAPTERS
REPORTS

4 WEB BASED TOOLS

4 VIDEOS PRODUCED

16 CONFERENCES, MEETINGS,
TRAININGS, WORKSHOPS,
AND MEDIA INTERVIEWS

16 NEWSLETTERS

70 LISTSERV POSTS
PRESENTATIONS

$21,447 in TRAVEL SUPPORT

$518,539 of LEVERAGED GRANT FUNDS

Photo Credit: Liz Fly

Collaborations to Support Coastal Climate Adaptation

CISA works directly with communities to assess climate vulnerabilities, identify potential adaptation strategies, and consider avenues for implementation in order to foster greater resiliency. Through the work of our Coastal Climate Extension Specialist, Liz Fly, this work has been particularly effective in moving from conversations to actions in coastal communities in South Carolina. Three examples are provided below.

Beaufort County, SC Incorporates Sea Level Rise into Its Comprehensive Plan

Beaufort County is located in the heart of the South Carolina Lowcountry, which sits just above sea level. County planners recognized their vulnerability to rising sea levels several years ago and initiated a collaboration with CISA and other partners to develop strategies that could be integrated into the County's Comprehensive Plan to address these risks. A series of interactions followed including decision maker interviews to gauge climate-related concerns, a 2013 Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) workshop to identify potential impacts of sea level rise as well as possible adaptation strategies, two 2014 public workshops during which local residents were able to weigh in on potential adaptation options, development of a detailed report outlining prioritized strategies in 2015, and finally, in 2017, the incorporation of findings into the Natural Resources chapter of the Beaufort County Comprehensive Plan. The plan includes recommendations to strengthen development and building standards, natural resource protection, and infrastructure and public facilities management. There are also recommendations to encourage communication and joint activities among government agencies and the private sector, noting the importance of cooperation to address the challenges faced by the community.

City of Folly Beach Develops Sea Level Rise Adaptation Report

The City of Folly Beach is a small, barrier island community facing a variety of coastal hazards, including the threat of sea level rise from both the ocean and marsh sides of the island. Referred to by local residents as "The Edge of America", Folly Beach is also a major tourist destination in SC making the maintenance of its beachfront properties and shoreline a top priority. The City first approached CISA to request technical assistance in the analysis of the future impacts of sea level rise to the community. This initial consultation led to a request for a more thorough assessment of their risks and support in identifying potential adaptation solutions. A VCAPS workshop was held in August 2016 with key decision makers from the City. The adaptation strategies identified during this workshop were then prioritized during three public workshops in April and May 2017. These strategies are laid out in the City's Sea Level Rise Adaptation Report. The City Council will consider a resolution to adopt the report and endorse the recommended actions included in it.

Support for the Charleston Resilience Network

The Charleston Resilience Network (CRN) is a volunteer-based effort composed of public and private sector stakeholder organizations in the Charleston, SC metropolitan area that have a collective interest in the resilience of communities, critical infrastructure, and socio-economic continuity to climate extremes and long-term climate change. The CRN works to foster a unified strategy and provide a forum to share science-based information, educate stakeholders, and enhance long-term planning decisions that result in resilience. In order to advance the group's mission, CISA partnered with the SC Sea Grant Consortium to hire a Resilience Program Coordinator. First held by Andrea Sassard and currently by Sylricka Foster, the Coordinator develops communications materials, such as the website, and engagement activities for the CRN, such as the Rendezvous for Resilience, held April 27, 2017, and bi-monthly Resilience Coffee Hours. The first Resilience Coffee hour, held May 23, 2017, brought 10 new organizations into the conversation. These events are designed to educate regional leaders and stakeholders about the CRN and provide opportunities to share work they are conducting within their own organizations to increase resilience in the region. The Resilience Coordinator is also heavily involved in organizing the Hampton Roads and Charleston Coastal Resilience Knowledge Exchange in collaboration with partners at VA Sea Grant.

CISA researchers are also supporting the CRN through work funded by a NOAA Regional Coastal Resilience Grant. This project is designed to identify opportunities to improve the capacity of the Charleston regional infrastructure to cope with nuisance and severe flooding. To date, research partners have been developing highly local, parcel-level flood models. These models will be presented to the CRN and at four stakeholder engagement workshops in summer 2017 to facilitate discussion about current and future flood risk and what actions can be taken from an individual level up to the municipal level.

Photo Credit: Chandler Green

2016 - 2017 HIGHLIGHTED ACCOMPLISHMENT

Engagements to Foster Climate Information Networks

Over the years, we have learned the unrivaled value of face-to-face interactions to enhance decision makers' abilities to understand and address current and future climate-related impacts. Therefore, we have prioritized organizing these interactions and supporting participation from key stakeholders. Highlights from two of these events in 2016 and 2017 are included below. A large part of the success in drawing local stakeholders to both of these events was travel support provided by CISA and partner organizations. In prior years, limited travel budgets were repeatedly cited as key constraints to participation. Therefore, CISA dedicated funding to facilitate participation for these local stakeholders.

2016 Carolinas Climate Resilience Conference

The 2nd Carolinas Climate Resilience Conference was held in September 2016. Conference attendance grew by nearly 40% from the first event, held in April 2014, and included a more diverse representation of sectors and individuals. In addition to two pre-conference workshops and three plenary sessions, there were more than 100 individual posters and presentations. Bob Inglis, former U.S. Congressman for South Carolina's 4th congressional district, was the keynote speaker. In 2011 Inglis began promoting free enterprise action on climate change and, in 2012, launched the Energy and Enterprise Initiative at George Mason University. Conference feedback was overwhelmingly positive and attendees cited the ability to connect to climate resources, tools, and expertise as a primary benefit of the event.

Photo Credit: Brooke Keppy

"The conference challenged me to think about the various effects that climate change is likely to have an impact on our operations. I will work to include those in our resiliency planning."

"There is so much good work going on, and so many great people working on climate resilience, and so much progress since the last conference. It gave me great hope!"

"I found huge value in the networking opportunities as well as the interactions that occurred between speakers and attendees during the talks."

~ 2016 Carolinas Climate Resilience Conference Attendees

Media Coverage of the 2016 Carolinas Climate Resilience Conference

- A conservative Republican tackles climate change
  - » The Charlotte Observer, September 9, 2016
- Columbia could again see floods like last year's
  - » The State, September 14, 2016
- Carolinas water managers brace for a drier - or sometimes wetter - climate future
  - » The Charlotte Observer, September 14, 2016
- SCIENCESpeak: Hurricane Matthew Proves Climate Change is Real and Here to Stay
  - » Insight News, October 26, 2016

Southeast & Caribbean Climate Community of Practice In-Person Meeting

On the heels of a successful meeting held in April 2016 on Tybee Island, GA, CISA helped organize a fourth meeting for the Southeast & Caribbean Climate Community of Practice April 24 – 26, 2017 in Charleston, SC. Sixty-eight participants from North Carolina, South Carolina, Georgia, and Florida represented a variety of sectors and organizations ranging from local and state government, extension professionals, and non-governmental organizations. Because of Hurricane Matthew's impacts throughout the region, it served as a focal point for meeting sessions which included discussions about the changing frequency and intensity of extreme events and associated impacts, bridging climate resilience and disaster planning, effective communication strategies during extreme events, and examples of successful resilience partnerships. Keynote speakers Jason Hurdich (Certified Deaf Interpreter) and Shonna Magee (SC Association of the Deaf) gained national acclaim when they signed for SC Governor Nikki Haley during the evacuation of the SC coast before Hurricane Matthew made landfall. They shared valuable lessons about communicating during natural disasters during the closing session.

"It was a pleasure for me to attend and to have participated in the SE & Caribbean Climate Community of Practice meeting... I praise the efforts put forth by the organizers, speakers and volunteers. It is very exciting to know there is a dynamic network which shares resources and tools to support future actions toward building climate resilient communities in our region. I am looking forward to sharing this experience and information within the Natural Resources Management Department and other potentially interested departments in Brevard County, and hopefully, start meaningful discussions to walk towards that direction."

~ Vanessa Arnal, Brevard County, FL Board of Commissioners

Photo Credit: Madeleine Russell

Photo Source: Fayetteville Observer

RESEARCH TO ADVANCE UNDERSTANDING OF CLIMATE & ITS IMPACTS IN THE CAROLINAS

CISA conducts applied research to answer stakeholders' questions about climate variability and extremes, projections of future climate, and climate-related impacts on the Carolinas' resources and communities.

Extreme Rainfall Analysis at the Water Basin Level

Following the extreme rainfall event in October 2015 in South Carolina, CISA researchers began to investigate the nature of heavy precipitation events in the Carolinas to improve information available to water resource managers in the region. By analyzing the historical record, probabilities for exceeding heavy precipitation thresholds were produced using basin-level precipitation totals. Considerable differences were found between point-based and area-based estimates of 1-, 2-, and 4-day annual maximum precipitation totals. This finding suggests that caveats are needed when using point-based estimates to represent areal estimates as model inputs for the purpose of storm water management and flood risk assessment. The data analysis method CISA used complements the point-based measurements available through NOAA's Atlas-14 product. Results have been shared with the SC State Climatology Office and hydrologists at the Columbia, SC National Weather Service Office, USGS South Atlantic Water Science Center, the SC Department of Natural Resources, and the SC Department of Health and Environmental Control. These interactions have been centered on evaluation and vetting of techniques in characterizing the October 2015 heavy rainfall and flooding event.

Public Health Impacts of Wildfire in the Carolinas

During the fall of 2016 an intense drought developed across interior portions of the Southeast US that culminated in the occurrence of numerous wildfires across the western Carolinas. The smoke from these fires spread out across the region, greatly reducing the air quality. In order to understand the public health implications of the degraded air quality, we are conducting a pilot study comparing emergency room visit data for a small cluster of counties in the mountains, western Piedmont, and Sandhills of North Carolina for the month of November. Modeled estimates of small particulate matter (PM2.5) were obtained from EPA and used to identify day to day variations in air quality. These variations were compared with day to day changes in emergency room visits, but no clear relationships were identified. We hypothesize that one or both of the following was occurring: Individuals who were vulnerable to smoke largely stayed inside; or, people affected by the smoke sought treatment in other facilities such as with school nurses, urgent care facilities, or with their primary physicians. Logs of child asthma reports in public schools have been requested from the NC Area Health Education Centers to test this portion of our hypothesis.

Assessing Vulnerable Water Infrastructure in Coastal Cities

CISA researchers are assessing vulnerability to extreme events and rising sea levels and identifying the populations most susceptible to public health risks from infrastructure failure through case studies of water and wastewater infrastructure in Morehead City, NC and Charleston, SC. By combining stakeholder consultation and GIS analysis, areas that may be priorities for mitigating public health susceptibilities were identified. Charleston has a number of healthcare facilities that are vulnerable to flooding and Morehead City has a potential evacuation hindrance at a major intersection. In addition to these place-based vulnerabilities, interesting organizational trends were identified. Many of the workshop participants indicated low levels of capacity to add or change institutions, policies, trainings, and culture within their organizations. Additionally, there were significant differences in the type and degree of emergency planning across operational sectors (healthcare, water utility, city emergency management department), with many of these organizations unaware of the plans and capabilities of other sectors. Water utilities in both locations were rather confident in their ability to prevent disruption of water services; however other utilities, healthcare facilities, and municipal emergency management departments have little accomplished in terms of planning for future scenarios, or incorporating sea level rise and climate change into their existing contingency plans. These place-based and organizational findings will be shared with each respective community and will contribute to the development of a susceptibility index of vulnerable sectors to health threats.

Climate & Water Resources: Climate Change Information for Local Decisions

While recent droughts, floods, and tropical storms in the Carolinas have drawn attention to the vulnerability of the region's water resources to climate events, decision makers are increasingly asking for information regarding how climate change will affect freshwater and coastal resources in the future. CISA researchers developed a synthesis article to provide guidance for addressing climate and water resources questions most relevant to audiences in the Carolinas. While some questions are generally about the use of climate information (e.g., "Which climate model output and scenarios are best suited for the Southeast?"), other questions aim to understand climate impacts (e.g., "How will climate change affect the ecosystems at Congaree National Park?"). Our approach is to encourage use of a variety of climate information and resources, including the historical record, to improve overall understanding of the systems in question, the linkages to climate, and variables (climate or non-climate) of greatest concern. We also work to clearly communicate the various levels of uncertainty associated with different climate variables and help decision makers and scientists determine which tools are most appropriate for specific questions.

OUTREACH & ENGAGEMENT TO FOSTER CLIMATE INFORMATION NETWORKS IN THE CAROLINAS

CISA seeks to be a trusted source of climate information and provides a variety of opportunities for dialogue around climate issues through communications and outreach materials as well as in-person meetings, workshops, and conferences. In addition to the resources listed below, the Appendix: CISA Deliverables, 2016 – 2017 provides a full list of communications, outreach, and engagement efforts.


Photo Credit: Sarah Smith

Communications & Outreach Materials

- The Carolinas Climate Connection, our quarterly newsletter, is circulated to over 1200 individuals. Based on evaluation results from the Carolinas Climate Resilience Conference, we revised the newsletter format to highlight specific case studies presented at the conference that demonstrate successful climate adaptation examples in the region, thereby extending the reach of this in-person event to additional education materials.
- The Carolinas Climate Listserv is circulated to 305 subscribers once to twice per week as relevant news becomes available.
- To reach a broader public audience, we maintain social media accounts on Facebook (152 followers) and Twitter (348 followers).
- CISA leads communications efforts for the Southeast and Caribbean Climate Community of Practice which includes social media accounts, a website, a quarterly newsletter, and member webinars.
- We maintain multiple lines of communication with over 2,000 Carolinas CoCoRaHS volunteers for the citizen science condition monitoring project. We circulate a monthly newsletter and hold quarterly conference calls during which we provide project news, drought status updates, and opportunities for volunteers to talk and learn from one another and the decision makers who use their condition monitoring reports.

Thank you and your staff for your continued commitment to this Listserv. The information provided is extremely useful; great resource for the state of South Carolina!

~ Will Salters, Coastal Planner, SC DHEC Office of Ocean and Coastal Resources Management


Photo Credit: Brooke Keppy

In-Person Workshops and Conferences

- The 2nd bi-annual Carolinas Climate Resilience Conference was held September 12-14, 2016, in Charlotte, NC with 272 attendees.
- CISA helped organize the 4th in-person meeting for members of the Southeast and Caribbean Climate Community of Practice April 24 – 26, 2017 in Charleston, SC with 68 attendees.
- Additional information about both of these events can be found in the "2016-2017 Highlighted Accomplishment" section.


Photo Credit: Brooke Keppy

Putting Climate in Context through Local Examples: Climate & Water Videos

CISA has now produced 21 short documentary style videos illustrating the many ways climate affects water resources and impacts the lives of South Carolinians. Four new videos were produced in the summer of 2016 covering topics ranging from species conservation to basin-level water resources management to changing water demand in a booming tourist area. Stories come from local perspectives around the state. Videos have been used in South Carolina high school and university geography courses to complement lesson plans and are available to all formal and informal educators through our website.

Improving Science Communication

CISA is always looking for opportunities to learn more about science communication and community engagement and share lessons about the value of engaging with decision makers. In 2016, Kirstin Dow was named a fellow of the American Association for the Advancement of Science Leshner Leadership Institute for Public Engagement with Science. Following the training, information was shared with the CISA network in a couple of ways. A full team webinar included a presentation on the highlights from the training and key resources. We also held a day-long climate communication training for 20 people including CISA staff, stakeholder partners, and University of South Carolina faculty interested in improving their science communication skills and doing more public engagement. This training was led by Susan Joy Hassol, Director of Climate Communication. Dow also spoke several times as AAAS events highlighting the importance of knowing your audience to engage with decision makers and the value of public engagement to enhance the depth and relevance of research conducted.

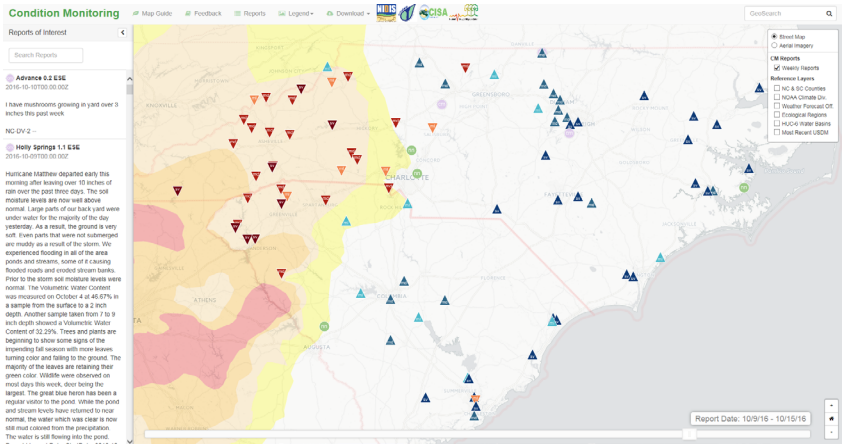

Photo Credit: Brooke Keppy

Outreach & Engagement, Continued

Web Based Tools to Display Integrated Climate Information & Research

CISA has now developed several web-based tools as components of different research projects to facilitate information sharing and use. Unique to each of these tools is their ability to integrate climate data with other contextual information for a value-added product that is more useful for decision support.

The CoCoRaHS Condition Monitoring Web Map is an experimental tool which depicts local, community-level conditions and how recent weather and climate events have affected those communities. Volunteer observers provide weekly reports through the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network website. The web map displays the reports and provides other contextual information, such as the US Drought Monitor Map, that can be used in the monitoring of drought onset, intensification, and recovery. The Carolinas map serves as a prototype for a national condition monitoring web map, which will display condition monitoring reports from CoCoRaHS observers throughout the country. The National map and is scheduled to be released in early September 2017.



The Convergence website houses a wealth of resources about public health impacts of various extremes, information about different types of vulnerabilities, and makes available open source peer-reviewed literature. The Heat Health Vulnerability Tool, which predicts the daily number of emergency department visits for heat-related illness across NC, is also available through this website. Heat safety infographics customized for various audiences, such as coaches and athletes, outside workers, and the elderly, are provided there. These materials were designed in collaboration with public health communications professionals to make the messages relevant and accessible.

The Carolinas Precipitation Patterns and Probabilities Atlas is an online resource for drought response committees, water resource managers, and other decision makers who plan for and manage water-related climate risks. The Atlas includes a wide range of statistical information about precipitation extremes in the Carolinas at the state, climate division, and station level displayed through maps and graphics. In order to integrate the climatological data with the impacts to society, there are additional pages provide narratives about major events. Currently, events pages include the October 2015 extreme rainfall and flood event and the 1998-2002 drought. Further event narrative pages are in development.

Key Publications

Farris, A. and E. Davis. 2016. Carolinas Climate Resilience Conference Final Report, September 12 – 14, 2016, Charlotte, NC.

- The CCRC final report provides an overview of the event as well as a summary of evaluation results which includes attendee feedback about climate-related concerns and information needs.

Lackstrom, K. and A. Farris. 2016. Coastal Carolinas Drought Early Warning System Meeting Summary Report, June 2, 2016, Wilmington, NC.

- This report was developed to summarize stakeholder feedback from the June meeting and, in turn, used to generate the Coastal Carolinas DEWS Strategic Plan.

Lackstrom, K., G. Carbone, D. Tufford, and A. Patel. 2016. "Climate and Water Resources in the Carolinas: Approaches to Applying Global Climate Change Information to Local Decisions," Journal of South Carolina Water Resources: Vol 3: Iss. 1, Article 7. http://tigerprints.clemson.edu/jscwr/vol3/iss1/7/

- This article provides guidance for addressing climate and water resources questions most relevant to audiences in the Carolinas.

Lu, J., Carbone, G. J. and Gao, P., 2017. Detrending crop yield data for spatial visualization of drought impacts in the United States, 1895–2014. Agricultural and Forest Meteorology, 237–238, 196-208. DOI: 10.1016/j.agrformet.2017.02.001

- This article presents a methodology to connect drought periods with impacts to crop yields and long-term spatial visualization to identify spatial patterns of vulnerability of corn to drought in the US.

Tuler, S., K. Dow, T. Webler, and J. Whitehead. 2016. Learning through participatory modeling: Reflections on what it means and how it is measured. In S. Gray, M. Paolisso, and R. Jordan, eds. Environmental Modeling with Stakeholders. Springer. pp 25-46.

- This article reflects on the challenges of designing participatory processes to promote social learning about risks.

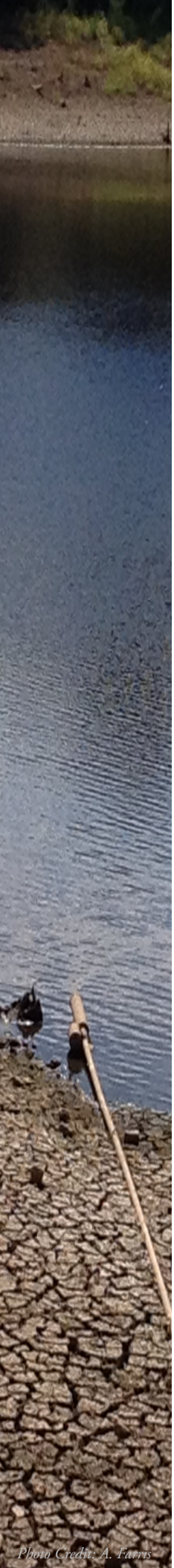


Photo Credit: A. Farris

OUR WORK IN PRACTICE

Convergence: Integrating Climate Science into Public Health Decision Making

During engagement sessions for the Heat Health Vulnerability Tool (HHVT), community members voiced needs for additional information and tools on climate extremes as well as barriers to building resilience. Chief among these was the desire to have information tailored to specific challenges faced by Carolina communities. Frustration over lack of access to research about the health impacts of climate extremes highlighted another need. And finally, participants indicated their desire to develop a better understanding of vulnerabilities within their communities and compare differences among communities throughout the state and region. These concerns about climate-related health impacts and barriers to increasing resilience established the basis for the Convergence website.

Convergence offers information about and tools to address the impacts from heat, drought, hurricanes, severe weather, and winter storms specific to the Carolinas. Tools housed on the site, such as the HHVT, allow users the opportunity to develop strategies to reduce the health impacts of extreme climate events. The HHVT is a community-collaborative tool, which integrates data from the National Weather Service along with variables of community vulnerability to produce a forecast that predicts days of high risk for heat-related illness. Using this data, public health officials, emergency preparedness professionals, and agricultural extension agents, among others, expect to develop plans for the prevention of heat-related illness, specifically targeted toward the vulnerable populations in their communities. Hospital emergency department officials are planning to use the HHVT forecast to prepare adequately for increasing numbers of patients to be seen in emergency departments.

Another aim of Convergence is to connect community decision makers with research regarding the health impacts of extreme climate events, particularly among vulnerable populations. Many communities do not have access to research libraries. A searchable database allows users to locate information and open-source published research. The FAQ section is designed to assist stakeholders in addressing community questions regarding climate extremes.

Finally, in collaboration with the UNC Research Hub data visualization experts, a series of visualizations have been created to increase understanding of vulnerabilities in the Carolinas. These include maps as well as other interactive visualizations focused on increasing awareness and understanding of age structure, poverty, housing, water resources, employment, infrastructure, transportation, and communication networks. These visualizations are a response from stakeholder feedback indicating that decision makers desire to deepen their understanding of vulnerability in their community, but also to understand how their community compares to surrounding communities.

Providing Tailored Climate Information for Drought Planning and Response

Spurred by impacts from the 2016 drought in the western Carolinas, stakeholders approached SC state climatologist, Hope Mizzell, to request information about drought planning, preparedness, and response. We began work in January 2017 to help Mizzell respond to these information requests and update information in current South Carolina drought planning and management documents.

Specifically, SC lawmakers received inquiries from their constituents asking how impact information was received and assessed by the SC Drought Response Committee and how the SC drought designations are considered for the US Drought Monitor map. This led lawmakers to consider how the current SC drought plan might be improved. To help Mizzell provide options for possible improvements, we are conducting a comparison of drought plans and other drought management documents from eight southeastern states. Additionally, language for a new state drought coordinator's position was composed, drawing from similar positions around the country. Work has also included developing updated and expanded material for the drought sections of the SC Hazard Mitigation Plan and the Emergency Operations Plan. Historical drought information drawn from the Carolinas Precipitation Patterns & Probabilities Atlas (Atlas) enhanced the state specific content of those documents. Finally, because of the predominance of drought in South Carolina over the last two decades, we are compiling impacts information across multiple sectors for this time period. This information will be developed into an events account to be added to the Atlas, to tell the story of recent drought in the state. Drawing from various components of this project, we developed materials for Mizzell to share with stakeholders for the SC Water Resources Summit Back to the Future of Drought in Clemson, SC on April 21, 2017. Feedback at this event regarding ways to engage water resource managers in further conversations about drought planning and preparedness has led to planning for a drought tabletop exercise, to be held in September 2017.

Photo Credit: A. Farris

From Research to Operations: National Launch of the Citizen Science Condition Monitoring Program

CISA researchers are engaging citizen scientists in on-the-ground data collection to improve understanding of the effects of rainfall, or a lack thereof, on ecosystems and communities in the Carolinas. We work closely with the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network to recruit volunteers to enter daily precipitation measurements and weekly status reports about local conditions. This "condition monitoring" approach has proven to be useful in documenting weather effects on under-reported sectors and impacts of extreme events such as hurricanes, as well as longer term seasonal change or change caused by the onset, intensification, and recovery from drought.

"CoCoRaHS observers sometimes note emerging dryness before it becomes newsworthy to the media, as in the case of parts of North Carolina. All twenty-one of the state's impacts stem from CoCoRaHS reports, documenting low pond levels, poor cover crop growth, concern about fire danger, wildlife boldly seeking food and water, dead shrubs, and so forth."

~ National Drought Mitigation Center February 2017 monthly drought summary call

Decision makers have lauded the effort, citing the citizen scientist's reports as a useful way to supplement data from other drought monitoring systems. Rebecca Ward (State Climate Office of North Carolina) uses the reports for the NC Drought Management Advisory Council weekly drought monitoring calls and regularly promotes the project through the SCONC Climate Blog and social media and at various events and meetings. Leonard Vaughn, Senior Service Hydrologist at the Columbia, SC National Weather Service office, frequently cites condition monitoring reports in his e-mails to the US Drought Monitor listserv.

I wanted to provide some input based on current emails. I really cannot justify not making some of the changes across SC and east-central GA. Rainfall has been meager at best since last week's discussion. So a slow continuation of increase to D0 across much of the area looks good...This looks consistent with the CISA Condition Monitoring map.

~ Leonard Vaughn, e-mail to US Drought Monitor listserv, March 29, 2017

Building on the success of the program in the Carolinas, condition monitoring reporting tools are now available to CoCoRaHS volunteers nationally. Before the national release, revisions were made to the online reporting form in response to feedback from users and volunteers. One revision was the addition of the condition monitoring scale bar, a seven category Likert scale, ranging from severely dry to near normal to severely wet. Observers' scale bar selections provide a snapshot of on-the-ground conditions, allowing report users to see where more investigation into individual descriptions might be warranted. Rebecca Ward is conducting a comparison of observers' scale bar selections with other, objective drought measures in order to assess how well the two match. In addition to the revised report form, an online web map was developed to spatially display reports in conjunction with other contextual information, such as the US Drought Monitor map. The Carolinas prototype map is currently being expanded to a national web map which will be publicly available on the CoCoRaHS website.

Since the national launch in October 2016, over 10,000 condition monitoring reports have been submitted by observers throughout the country. We continue to work with CoCoRaHS and partners to develop education materials in order to train new observers and raise awareness about the availability of the reports to potential users. National scale products in development include a video animation for training and a recorded demonstration of the national web map, both scheduled to launch in September 2017.

Contributions to the Fourth National Climate Assessments

- A regional engagement workshop for the Southeast Chapter of NCA4 was held in Raleigh, NC on March 16, 2017. Ashley Ward attended to represent CISA and public health concerns in the region. A satellite meeting was held in Charleston, SC, for which Liz Fly helped with logistical coordination.
- David Reidmiller, Director of the National Climate Assessment, led a session on the development of NCA4 and the Southeast and Caribbean chapters at the in-person meeting of the Southeast and Caribbean Climate Community of Practice.
- Kirstin Dow is serving as a lead author for the Southeast Chapter. The first order draft has been submitted for review. Development of the chapters will continue into 2018.

Photo Credit: Chandler Green

CISA Contributions to the NIDIS Drought Early Warning System for the Coastal Carolinas

Launched in 2012, the Coastal Carolinas DEWS focuses on 1) improving understanding of the unique vulnerabilities and impacts of drought on coastal ecosystems and 2) developing tools, information, and other resources that will help managers and decision makers integrate drought and coastal resource management activities.

Several CISA projects contribute to the Coastal Carolinas DEWS, through building understanding of droughts' effects on the Carolinas' coastal ecosystems, developing new approaches and products to improve the use of drought information, and engaging with regional decision makers on drought issues.

Coastal Carolinas DEWS Program Coordination

Team Members: Lackstrom, Farris, Dow

Overview: CISA serves as the main point-of-contact for NIDIS Coastal Carolinas (CC) DEWS activities. This includes disseminating information about program activities to drought decision makers and stakeholders in the Carolinas and maintaining communications and coordination with NIDIS and the DEWS project partners.

2016 – 2017 Activities:

- We worked with NIDIS staff to develop the draft CC DEWS Strategic Plan. Activities included convening stakeholders and organizing and preparing materials for the June 2016 strategic planning meeting; writing the meeting report; contributing to the writing and editing of the draft plan; and maintaining communications with DEWS partners throughout the process via webinars (October 2016, December 2016) and e-mail.
- We also worked with partners to develop and disseminate information about the CC DEWS program.

Deliverables: June 2016 meeting report, draft CC DEWS Strategic Plan, updated 2-pagers about the CC DEWS program and individual projects, updates to CC DEWS content on the drought.gov website, and presentation and organized sessions at stakeholder meetings.

Communicating Coastal Drought Early Warning Information

Team Members: Lackstrom, Farris, Guiseppe, Rouen, R. Ward

Overview: The goal of this project is to coordinate communication and outreach efforts and promote an integrated approach to drought early warning communications, messaging, and outreach in the Coastal Carolinas. We will develop a draft CC DEWS communications plan, recommendations for ongoing communications efforts, and new coastal drought content to disseminate to DEWS partners and stakeholders.

2016 – 2017 Activities:

- We are developing an inventory of drought resources in the Carolinas and synthesizing prior work to identify drought information use and needs, particularly as it pertains to coastal drought, the CC DEWS, and drought information channels in the Carolinas.
- We are also developing a coastal drought story map as a new mechanism to communicate about coastal drought and CC DEWS projects in a user-friendly format for stakeholders and the public.

Deliverables: Work is in progress and expected to be completed by August 2017.

Advancing the Development and Use of the Coastal Salinity Index

Team Members: Lackstrom, Tufford, Rouen

Overview: The Coastal Salinity Index (CSI) was developed as a way to characterize coastal drought by monitoring the freshwater-saltwater interface. The tool is intended to improve understanding of the effects of changing salinities on fresh and saltwater ecosystems, fish habitat, and freshwater availability for municipal and industrial use. In close collaboration with DEWS partner Paul Conrads (USGS South Atlantic Water Science Center), we are comparing the CSI with environmental response variables and engaging with decision makers to pilot the CSI's use and applications.

2016 – 2017 Activities:

- We worked with USGS and DEWS partners to identify and obtain salinity datasets to calculate the CSI for different locations and ecological response datasets to assess linkages between ecological indicators and salinity levels as expressed by the CSI.
- We are conducting a literature review to synthesize information regarding salinity and drought effects on coastal ecosystems.
- The establishment of the CSI working group and other user engagement activities (presentations, meetings) have helped with the development of the CSI and will ensure that final products meet the needs of DEWS partners and stakeholders.

Deliverables: Updated 2-pager (September 2016, March 2017); Project spreadsheets that contain an inventory of salinity datasets and potential ecological response datasets for the CSI project, the data source, location, frequency of data collection, and other details; Products from CSI user engagement activities: working group webinars, meeting presentations, and notes (December 2016, April 2017); conference sessions and presentations to DEWS partners and potential CSI users

Data Management: Water quality and ecological responses dataset: This spreadsheet contains a list of salinity datasets and potential ecological response datasets, the websites where the data are available online, and the article in which the dataset was identified. Additional details include location, study period, and frequency of data collection. The dataset is stored on a secure server. For access, contact Kirsten Lackstrom, lackstro@mailbox.sc.edu or 803.777.3563.

Citizen Science-Condition Monitoring Project

Team Members: Farris, Lackstrom, Davis, Guiseppe, Selvaraj, Sullivan

Overview: This project engages with citizen scientists and the Community Collaborative Rain, Hail, and Snow (CoCoRaHS) network to promote drought impacts reporting. Observers provide weekly "condition monitoring" reports to document effects of weather and climate on their communities. This project addresses a need identified by DEWS stakeholders for improved understanding of drought impacts and for tools and processes to facilitate the use of impacts information into decision making.

2016 – 2017 Activities:

- See From Research to Operations: National Launch of the Citizen Science Condition Monitoring Program, for more information on how these reports are meeting decision maker information needs and expanding to the national level.
- We maintain regular communications and outreach with volunteer observers to provide educational resources and encourage long-term participation in the project.
- We continue to evaluate resources and tools developed throughout the project, particularly the condition monitoring scale bar and web map.
- Engagement with decision makers allows us to assess how reports are used and applied for drought monitoring and decision making.

Deliverables: Scale bar and updated condition monitoring report form, web map (version 2.0), outreach and training materials, presentations with and to project partners, project overview/manuscript (submitted to BAMS)

Data Management: CoCoRaHS Condition Monitoring Reports are volunteer reports describing how recent precipitation, or a lack thereof, has affected their local community and environment. All reports are publicly available on the CoCoRaHS website: www.cocorahs.org. Questions about the reports can be directed to Amanda Farris, afarris@sc.edu or 803.777.6875.

Carolinas Precipitation Patterns & Probabilities Atlas

Team Members: Carbone, Beidel, Gao, Konrad, Lu, McLeod

Overview: DEWS stakeholders and decision makers have indicated the need for Carolinas-focused information about extremes (drought, heavy rainfall) and normal precipitation patterns. The Carolinas Precipitation Patterns & Probabilities Atlas (Atlas) provides over 1,000 downloadable maps and figures characterizing various measures of precipitation and drought. It offers information not readily available from other sources, such as frequency and duration of both dry and wet events, and photographs, videos, graphics, and narratives of the impacts of drought and heavy precipitation events in the Carolinas.

2016 – 2017 Activities:

- We continue to build out and enhance the maps, graphics, and other products available through the Atlas.
- We have obtained user feedback at several events and conferences in the Carolinas which was used to improve Atlas products and functionality.
- We have adapted information from the Atlas to provide tailored drought products for the South Carolina Hazard Mitigation Plan update.

Deliverables: The Atlas was made available on the CISA website in fall 2016.

Data Management: The Atlas is a public resource, accessible at www.cisa.sc.edu/atlas. All maps and graphics are freely downloadable with appropriate citation. Sources of public datasets used to develop various Atlas products are listed under each graphic. Questions should be directed to Greg Carbone at carbone@mailbox.sc.edu or 803.777.0682.

Research to Advance Understanding Of Climate and Its Impacts in the Carolinas

Basin-Level Analysis of Extreme Rainfall Events

Team Members: Carbone, Gao

Overview: Following on stakeholder information needs about extreme rainfall after the October 2015 flooding event in South Carolina, CISA researchers are investigating observational records and model output to understand the nature of extreme precipitation in the Carolinas. The research aims to overcome challenges associated with insufficient sample sizes due to limited meteorological stations and observations, the ability of point data to represent the volume of water affecting an entire basin, and estimating infrequent precipitation events.

2016-2017 Activities:

- Research findings are included in the "Research to Advance Understanding of Climate and Its Impacts in the Carolinas" section on pg 9.
- Results have been shared with various state agencies in SC with interest in water resources management. Interactions have been centered on evaluation and vetting of our techniques in characterizing the 2015 floods in SC.

Deliverables:

- Carbone, G.J. and P. Gao. 2016. "How extreme was the October 2015 precipitation event in SC?" Carolinas Climate Resilience Conference, September 12 – 14, 2016, Charlotte, NC.
- Gao, P., G.J. Carbone, Lu, J., D. Guo. An area-based approach for estimating extreme precipitation probability. Submitted to Geographic Analysis June 2017.
- Interactive maps visualizing 1- to 5- day heavy precipitation events are available on the Carolinas Precipitation Patterns & Probabilities Atlas website.

Data Management: We generated bootstrapped samples of 1-, 2-, and 4-day rainfall events across six regions. These samples are stored on a networked hard drive maintained by Peng Gao. Questions should be directed to Greg Carbone at carbone@mailbox.sc.edu or 803.777.0682.

Historic Drought Impacts to Agriculture in the Carolinas

Team Members: Carbone, Lu, Gao

Overview: This project began as a complement to the Carolinas Precipitation Patterns & Probabilities Atlas. By also mapping crop yield, we were able to show connections between growing season droughts and reductions in crop yield. Our research attempts to "detrend" the time series to account for technological changes that have improved crop yield through time, and to blend remotely-sensed measures of vegetative health with point-based meteorological observations.

2016 – 2017 Activities:

- Crop yield data produced through the "detrending" process were used to produce NC and SC county-level corn and soybean anomaly maps that will be posted to the Atlas website.
- Research results were also used to create a new Integrated Scaled Drought Index (ISDI). The ISDI incorporates agricultural data with climate variables including temperature, precipitation, and soil moisture, to combine a range of important components controlling agricultural drought processes. NC and SC ISDI maps will also be incorporated into the Atlas.

Deliverables:

- Lu, J., Carbone, G. J. and Gao, P., 2017. Detrending crop yield data for spatial visualization of drought impacts in the United States, 1895–2014. Agricultural and Forest Meteorology, 237–238, 196-208. DOI: 10.1016/j.agrformet.2017.02.001
- Presentations at academic and stakeholder conferences

Data Management: We developed SC and NC county-level corn and soybean yield anomaly maps and maps to display the SC and NC Integrated Scaled Drought Index (ISDI). These are currently stored on a networked hard drive maintained by Junyu Lu, but will be made publicly available on the Carolinas Precipitation Patterns & Probabilities Atlas. Questions should be directed to Greg Carbone at carbone@mailbox.sc.edu or 803.777.0682.

Climate and Waterborne Disease in North Carolina

Team Members: Konrad, Downs

Overview: This research assesses relationships between climate variables and waterborne disease, analyzing patterns of gastrointestinal (GI) illness across different regions, demographic groups, and precipitation patterns in North Carolina. Early findings revealed relationships between GI illness and heavy rainfall, suggesting that surface runoff contaminated by harmful bacteria may have entered the water supply.

2016 – 2017 Activities:

- A more detailed, statistically robust analysis is underway to pinpoint geographic regions where GI illness is most prevalent and the weather patterns leading up to GI illness occurrences. This analysis has revealed a number of additional, confounding factors, such as seasonal flu, that may also lead to GI illness.

Deliverables: A statistical model is under development to help tease out these confounders in order to isolate where and when precipitation extremes lead to increases in GI illness. We are working to develop a GIS map layer that shows, on a local scale, where people are getting their water. An improved understanding of drinking water sources will also help assess potential associations between weather events, water quality, and GI illness.

Data Management: Health data was obtained through the NC DETECT database, an epidemiological syndromic surveillance system. This data is protected and not available for public use. Precipitation data was obtained through the PRISM Climate Group at Oregan State University, which has current and historic climate datasets available at multiple spatial/temporal resolutions. Datasets and maps are freely downloadable with appropriate citation. Questions should be directed to Chip Konrad, cek@email.unc.edu or 919.962.3873.

Public Health Impacts of Wildfire Smoke

Team Members: Konrad, McLeod, A. Ward

Overview: Spurred by the occurrence of numerous drought-induced wildfires across the western Carolinas in the fall of 2016, this research seeks to identify public health impacts caused by degraded air quality from wildfire smoke.

2016 – 2017 Activities:

- Modeled estimates of small particulate matter (PM2.5), obtained from EPA, were used to identify day to day variations in air quality. These variations were compared with day to day changes in emergency room visits related to respiratory disease. No clear relationships were identified in any of the counties in the study.
- Hypothesizing that air quality related health impacts may be better detected by occurrences outside emergency department visits, additional datasets representing asthma-related issues in school children have been requested.

Deliverables: Konrad, C., J. McLeod, A. Ward, S. Smith, and A. Hirsch. "The Southeast U.S. Drought of 2016 and Public Health Impacts of Wildfire Smoke." Climate Prediction Applications Science Workshop, May 2- 4, 2017, Anchorage, AK.

Data Management: This project used PM2.5 data obtained from the EPA and hourly surface wind observations for the Asheville Regional Airport, NC, which were compared with emergency department visit data from NC DETECT, North Carolina's epidemiological syndromic surveillance system, to assess patterns in ED visits and degraded air quality. Data from NC DETECT is protect and not available for public use. The results of this analysis are stored on a secure hard drive maintained by Jordan McLeod (jtmcleod@email.unc.edu, 919.843.2704). To assess relationships between degraded air quality and impacts to school children, the PM2.5 data and hourly surface wind observations will be analyzed alongside data on school absenteeism and school nurse visits for asthma, acquired through a variety of sources at the NC Health and Human Services, Division of Public Health, and the NC Area Health Education Centers. Questions about these data should be directed to Ashley Ward (arward@email.unc.edu, 919.962.7470).

Collaborations to Support the Implementation of Climate Adaptation Strategies

Assessing Climate Sensitivity and Long-Term Water Supply Reliability with a North Carolina Water System

Team Members: Patel, Carbone

Overview: In collaboration with the Orange Water and Sewer Authority (OWASA), a water utility in Carrboro, NC, we are assessing the vulnerability of the utility's raw water supply to changing climatic conditions. The goal of the project is to help the utility incorporate climate change into their long-range planning. The analysis focuses on understanding the nature of climate changes that are consequential to the utility's planning decisions in order to provide credible and planning-relevant information based on global and regional scale climate projections.

2016 – 2017 Activities:

- An analysis of the utility's operations to climate impacts shows that the combined effect of the length of a drought and its severity can tell us when reservoir levels are likely to fall below 20% storage capacity, a critical threshold in their supply planning. Preliminary findings suggest that, in most cases, only intense droughts lasting approximately 24 months or longer seem to reduce the reservoir to these critically low levels.
- We are also assessing plausible future drought characteristics using global and downscaled climate model projections. Results are shared with the utility periodically to fine-tune communications of the findings for clarity and usefulness in their planning processes.

Deliverables: Presentations at regional stakeholder conferences to share the project methodology. Poster presentation at the 2017 AAG annual meeting

Data Management: Simulation of a rainfall-runoff and a reservoir operation model with stochastic meteorological inputs showed the magnitude and severity of droughts that lead to reservoir levels falling below OWASA's critical capacity (<20% of full pool levels). The output from these simulations is stored on a secure network drive maintained by Aashka Patel (aashkajp@gmail.com).

A Community-Wide Health Risk Assessment of Vulnerable Water Infrastructure in Coastal Cities

Team Members: Allen, Fly, Hanks, Lovelace, Montz, Whitehead

Overview: This project, funded by NOAA's Coastal and Climate Applications (COCA) program, is a four-step process to determine health-related impacts that result from coastal water and wastewater infrastructure vulnerability to extreme events and sea level rise. Using extensive stakeholder engagement in two pilot communities, we are developing a susceptibility index of vulnerable sectors to potential health threats from infrastructure damage or failure.

2016 – 2017 Activities:

- Stakeholder interviews and workshops were conducted in the two pilot communities, Morehead City, NC and Charleston, SC, to assess perceptions of water and wastewater infrastructure and public health vulnerabilities. Discussions encouraged stakeholders to consider what adaptation they have or have not enacted to prepare for climate change.
- Information from these engagements will be used to develop the susceptibility index, which will then be tested at a tabletop exercise in fall 2107.
- In order to make the process and products transferable to other coastal communities, a guidebook will be compiled from the various project components.

Deliverables:

- Two stakeholder workshops - one in Charleston, SC (22 attendees) and one in Morehead City, NC (18 attendees)
- Vulnerability matrix exercise: https://sites.google.com/g.cofc.edu/resilience-matrix-exercise/home
- White paper on "Public Health Impacts of a Water Infrastructure Failure in Charleston, South Carolina" written by MUSC MPH student Ariel Christensen
- Multiple presentations at stakeholder and academic conferences

Data Management: Online portals for stakeholders to view hazard and sector layers were developed for the engagement workshops. The Morehead City, NC portal is available at: http://arcg.is/2lVqanS. Charleston, SC, contains sensitive water infrastructure data and thus is only available to workshop attendees. For questions, please contact Susan Lovelace, susan.lovelace@scseagrant.org or 843.953.2078.

Planning for Sea Level Rise in the City of Folly Beach, SC

Team Members: Fly, Dow

Overview: CISA provided support to the City of Folly Beach, SC to consider vulnerabilities to sea level rise and identify potential adaptation strategies that could help to mitigate current and future impacts.

2016 – 2017 Activities:

- Stakeholder input about their most pressing concerns and viable adaptation solutions to current flooding and future sea level rise was generated through an initial online survey, a VCAPS workshop with City and state officials, and two public workshops.
- Based on this input, the City's sea level rise adaptation report was released in May 2017. The report highlights adaptation options within the categories of water infrastructure management, land management, education, transportation, and coordination, collaboration, and cooperation.

Deliverables: Folly Beach Sea Level Rise Adaptation Report

Building Regional Resilience Capacity in Charleston, SC

Team Members: Fly, Foster, Sassard, Dow, Carbone

Overview: Established in 2015, the Charleston Resilience Network is composed of public and private sector stakeholder organizations within the Charleston, SC metropolitan area that have a collective interest in the resilience of communities and critical infrastructure to climate extremes and long term climate change. The CRN works to foster a unified strategy to address these challenges and provide a forum to share science-based information, educate stakeholders, and enhance long-term planning decisions that increase resilience.

2016 – 2017 Activities:

- The CRN received a NOAA Regional Coastal Resilience Grant to understand the capacity of Charleston's infrastructure to cope with nuisance and severe flooding. Work is in progress by project partners at the College of Charleston to develop highly local, parcel-level flood models. These maps will be used in summer 2017 to engage communities in discussions on current and future flood risk.
- One of the most important successes to date for the network has been connecting a diverse group of decision makers within the resilience realm in the Charleston region. In order to help facilitate this process, CISA and the SC Sea Grant Consortium partnered to fund a Regional Resilience Coordinator.

Deliverables:

- Rendezvous for Resilience, April 27, 2017 (40 attendees); Resilience Coffee Hour, May 23, 2017 (27 attendees)
- Levine, N., N. Rubin, and T. Callahan. "High Resolution Flood Modeling for Planning, Mitigation, and Response, Charleston, SC." Presentation at the 2017 Geological Society of America Southeastern Section Meeting, March 30-31, 2017, Richmond, VA.

South Atlantic Regional Research on Coastal Community Resilience

Team Members: Dow, Fly

Overview: The four South Atlantic Sea Grant programs (GA, FL, NC, and SC) received funding from the NOAA Office of Coastal Management to begin a new South Atlantic Regional Research on Coastal Community Resilience program. The overall goal of the project is to conduct and evaluate a participatory process to help local governments build capacity to better visualize, understand, and plan for coastal hazard risks. CISA's main roles in this partnership are collaborating in the design of the VCAPS processes and partnering with the City of Beaufort, SC.

2016 – 2017 Activities:

- Original conversations indicated that Beaufort was particularly interested in the issues of historic preservation approaches to flood mitigation. Initial level research has begun in this area.
- Hurricane Matthew, which made landfall on the South Atlantic coast in October 2015, caused delays in the project as communities worked to respond to storm damages. The experience of Hurricane Matthew may also lead to some adjustments to the community's area of focus as improving its CRS score is an even greater priority. Addressing recovery across multiple jurisdictions has also become a priority.

Deliverables: Presentations by K. Dow to the American Association for the Advancement of Science at two separate events.

Providing Innovative Decision Support Services

Heat-Health Vulnerabilities in North Carolina

Team Members: Konrad, A. Ward

Overview: Working with data from the NC Disease Event Tracking and Epidemiologic Collection Tool (NC DETECT) we developed statistical relationships between weather and climate variables such as precipitation and temperature and emergency department visits for heat-related illness. The statistical relationship was then used to develop a predictive model, the Heat Health Vulnerability Tool (HHVT), which uses forecasted heat index from the National Weather Service, along with community vulnerability measures, to display a 5-day estimated change in emergency room visits for each county in North Carolina.

2016 – 2017 Activities:

- Using stakeholder feedback from engagements, revisions to the HHVT were implemented to better represent and communicate potential risks to vulnerable populations. The tool now inputs daily maximum heat index (rather than maximum temperature), a metric stakeholders were already using to gauge risk. Additionally, a color ramp on the display corresponds to the level of warning for the number of potential heat-related emergency department visits.
- In collaboration with the NC State University's Geocognition Lab, an evaluation is currently underway to measure the usability and functionality of the tool using eye-tracking software.
- We are working in collaboration with the NC Division of Public Health NC BRACE program to design, implement, and monitor a prevention strategy for heat-related illness, which will include use of the HHVT.

Deliverables:

- Updated version of the HHVT including a color ramp to communicate risk and incorporating the daily maximum heat index into the tool. The HHVT is now housed on the Convergence website.
- A series of stakeholder engagement and feedback sessions across eleven counties in the Sandhills region of NC, ranging in size and type from a webinar, to larger informational engagements, to small 2-3 person engagements.
- Tool demonstrations at several stakeholder conferences and events.

Data Management: The HHVT model is comprised of data from NC DETECT, North Carolina's epidemiological syndromic surveillance system, and maximum temperature data and heat index forecast data from the National Weather Service. Data from NC DETECT is protect and not available for public use. This data, in addition to NWS data, are stored at the State Climate Office of North Carolina. Questions should be directed to Ashley Ward (arward@email.unc.edu or 919.962.7470).

Convergence: Climate-Health Vulnerabilities Website

Team Members: Ward, Konrad, McLeod, Smith

Overview: Building on the development of the Heat Health Vulnerability Tool (HHVT), we are working with stakeholders to provide even more decision-relevant information about the connections between climate extremes and health through the Convergence web portal. Convergence provides links to research findings, information on climate extremes in the Carolinas, and the populations most vulnerable to their impacts.

2016 – 2017 Activities:

- Convergence content and design was developed throughout the fall of 2016 and winter/spring of 2017. The framework for the website was substantially shaped by community feedback and information needs.
- A webinar was hosted on May 3, 2017 to launch the Convergence website with stakeholders.
- Evaluation efforts will be conducted during summer 2017. In addition to further build out of the existing content and revisions based on evaluation feedback, the website will continue to be improved by incorporating projects and visualizations for South Carolina, expanding access via Spanish Language, and adding climate extremes information as requested by stakeholders.

Deliverables:

- Convergence web portal: http://convergence.unc.edu
- Launch webinar, May 3, 2017, 59 participants
- "Incorporating Stakeholder Feedback into Tool Development." Climate-Health Conference; East Carolina University, Greenville, NC; March 23, 2017

Supporting South Carolina's Drought Response Program

Team Members: Altman, Dow, Farris, Lackstrom, Mizzell

Overview: CISA and the South Carolina State Climatology Office (SC SCO) initiated this project with the overarching goal of assisting the SC SCO in advancing the State's Drought Response Program and improving drought preparedness and response.

2016-2017 Activities:

- Major components of this project include collecting and analyzing drought impacts on South Carolina; assessing approaches to drought response in the Southeast to learn about neighboring states' drought management strategies and tools; and developing informational resources that can be used to support South Carolina's drought planning and communications processes.
- More information about progress to date can be found in the "Providing Tailored Climate Information for Drought Planning and Response" section.

Deliverables: Drought updates for the SC EOP and HMP, SC Drought Coordinator position description, presentation materials

Appendix: CISA Deliverables, 2016 - 2017

Books/Book Chapters

Moser, S., K. Dow, and S.P. Tuler. 2017. Out of Harm's Way: Challenges in Reducing Current and Future Coastal Risk Exposure. In Kasperson, R. E. ed. Risk Conundrums: Solving Unsolvable Problems. Earthscan, London.

Tuler, S.P., K. Dow, and T. Webler. 2017. How Can We Learn More from Learning About Risk Controversies. In Kasperson, R.E. ed. Risk Conundrums: Solving Unsolvable Problems. Earthscan, London.

Tuler, S., K. Dow, T. Webler, and J. Whitehead. 2016. Learning through participatory modeling: Reflections on what it means and how it is measured. In S. Gray, M. Paolisso, and R. Jordan, eds. Environmental Modeling with Stakeholders. Springer. pp. 25-46.

Conferences, Meetings, Trainings, and Workshops

Carolinas Climate Resilience Conference. September 12-14, 2016. Charlotte, NC. 272 attendees.

Dow, K. Communicating on Climate, A Training with Susan Joy Hassol. January 5, 2017. Columbia, SC. 20 attendees.

Farris, A. and E. Fly. Southeastern Caribbean Climate Community of Practice In-Person Meeting. April 24-26, 2017. Charleston, SC. 88 attendees.

Farris, A. Exhibit table at Waccamaw Conference. February 11, 2017. Conway, SC. 100 attendees.

Farris, A. CoCoRaHS Condition Monitoring Webinar Training. October 17, 2016. 15 attendees.

Farris, A. CoCoRaHS Condition Monitoring Observer Calls. July 28, 2016, January 25, 2017, May 26, 2017.

Fly, E. Community-wide Public Health Risk Assessment of Vulnerable Water Infrastructure in Coastal Cities, Morehead City Workshop. March 20, 2017. Morehead City, VA. 18 attendees.

Fly, E. Community-wide Public Health Risk Assessment of Vulnerable Water Infrastructure in Coastal Cities, Charleston Stakeholder Workshop. February 10, 2017. Charleston, SC. 22 attendees.

Fly, E. Charleston Climate Communications Course, November 9, 2016. Charleston, SC.

Conferences, Meetings, Trainings, and Workshops (Cont.)

Fly, E. Beaufort Climate Communications Course, November 7, 2016. Beaufort, SC.

Fly, E. Vulnerability, Consequences, and Adaptation Planning Scenarios Workshop. August 1, 2016. Folly Beach, SC. 13 attendees.

Lackstrom, K. NIDIS Coastal Carolinas Drought Early Warning System (DEWS) Meeting. June 2, 2016. Wilmington, NC. 29 attendees. Co-organized by CISA and NIDIS.

Ward, A. Introduction to Convergence Website, Webinar. May 3, 2016. 59 attendees.

Journal Articles

Cumbie-Ward, R.V. and R.P. Boyles. 2016. "Evaluation of a High-Resolution SPI for Monitoring Local Drought Severity." Journal of Applied Meteorology and Climatology, 55, 2247-2262. DOI: doi.org/10.1175/JAMC-D-16-0106.1.

Lackstrom, K., G. Carbone, D. Tufford, and A. Patel. 2016. "Climate and Water Resources in the Carolinas: Approaches to Applying Global Climate Change Information to Local Decisions," Journal of South Carolina Water Resources: Vol 3: Iss. 1, Article 7. Available at: http://tigerprints.clemson.edu/jscwr/vol3/iss1/7

Lu, J., Carbone, G. J. and Gao, P. 2017. "Detrending crop yield data for spatial visualization of drought impacts in the United States, 1895–2014." Agricultural and Forest Meteorology, 237–238, 196-208. DOI: 10.1016/j.agrformet.2017.02.001.

Newsletters

Farris, A. and K. Guiseppe. 2017. Carolinas Climate Connection, 1st Quarter, March 2017.

Farris, A. 2016. Carolinas Climate Connection, 4th Quarter, December 2016.

Farris, A. 2016. Carolinas Climate Connection, 3rd Quarter, October 2016.

Farris, A. 2016. Carolinas Climate Connection, 2nd Quarter, July 2016.

Sullivan, M., E. Davis, A. Farris, K. Guiseppe, K. Lackstrom, S. Selvaraj. CISA and CoCoRaHS Condition Monitoring Newsletter. 12 Monthly Issues, June 2016 – May 2017.

Project and Research Information Documents

Farris, A., K. Bogan, R. Boyles, M. Childress, P. Conrads, K. Lackstrom, G. Carbone. NIDIS Carolinas Drought Early Warning Project Information Sheets. Columbia, SC. Updated September 2016.

Lackstrom, K., P. Conrads, A. Farris, and L. Rouen. NIDIS Coastal Carolinas DEWS: Using Salinity Data to Develop a Coastal Salinity Index. Updated March 2017.

Media Interviews

Dow, Kirstin. "What Climate Change Means for Columbia." Interview. Free Times. May 3, 2017. Print.

Dow, K. "Do IPCC Reports Communicate Effectively?" Interview. Inside Climate News. August 5, 2016. Web.

Farris, A. "U of SC Researchers looking for Weather Watchers." Interview. USC News. March 27, 2017. Web.

Farris, A. "March Madness for Weather Observers." Interview. WACH Fox57. March 24, 2017. Television.

Fly, L. "Rising Water Pushed Officials, Businesses, Environmentalists toward 'Resilience' Agenda." Interview. Charleston Regional Business Journal. May 9, 2017. Print.

Fly, L. "A Matter of Hard Choices: The Struggle to Preserve Charleston's Working Waterfront Spurring Collaborative Effort." Interview. The Post and Courier. January 22, 2017. Print.

Fly, L. "When a City Stops Arguing About Climate Change and Starts Planning." Interview. Next City. November 7, 2016. Web.

Fly, L. "Parris Island under water? One study says it could happen." The Beaufort Gazette. Interview. August 19, 2016. Print.

Konrad, C. "Bill would protect hurricane forecasting programs." Star News Wilmington. April 14, 2017. Print.

Konrad, C. "Is climate change behind the rise in extreme tornado outbreaks?" The Christian Science Monitor. December 2, 2016. Web.

Konrad, C. "The raging wildfires in the Southeast could be a glimpse of what's to come." Washington Post. November 30, 2016. Web.

Konrad, C. "Gatlinburg, Tennessee Has Burned and Weather Played a Role." Forbes Magazine. November 29, 2016. Print.

Media Interviews (Cont.)

Konrad, C. "What a Warmer Future Means for Southeastern Wildfires." Climate Central. November 23, 2016. Web.

Konrad, C. "U.S. Senate candidates Richard Burr and Deborah Ross said this about climate change." Winston-Salem Journal. October 16, 2016. Print.

Ward, A. "Local Knowledge Key in Responding to Climate Change." NC Health News. March 23, 2017. Print.

Ward. R. State Climate Office of North Carolina Blog posts that mention/feature CoCoRaHS Condition Monitoring or CISA:

- April 2016 Climate Summary (posted May 1, 2017): http://climate.ncsu.edu/climateblog?id=233
- CoCoRaHS Condition Monitoring Reports Add a Narrative to the Numbers (posted March 23, 2017): http://climate.ncsu.edu/climateblog?id=230
- Rapid Reaction: An Unusual Event for NC Drought Monitoring (posted March 2, 2017): http://climate.ncsu.edu/climateblog?id=228
- December 2016 Climate Summary (posted January 4, 2017): http://climate.ncsu.edu/climateblog?id=224
- November 2016 Climate Summary (posted December 1, 2016): http://climate.ncsu.edu/climateblog?id=222
- October 2016 Climate Summary (posted November 1, 2016): http://climate.ncsu.edu/climateblog?id=218
- Rapid Reaction: Drought Intensifies in Western NC (posted October 20, 2016): http://climate.ncsu.edu/climateblog?id=217
- Upcoming Webinar about New Phase of CoCoRaHS Condition Monitoring Project (posted October 13, 2016): http://climate.ncsu.edu/climateblog?id=216

Ward, R. Carolinas Climate Resilience Conference Mentions in State Climate Office of North Carolina Climate Blog:

- Pre-Conference Workshops for the 2016 Carolinas Climate Resilience Conference (August 3, 2016): http://climate.ncsu.edu/climateblog?id=199
- Looking forward to the 2016 Carolinas Climate Resilience Conference (posted July 26, 2016): http://climate.ncsu.edu/climateblog?id=198

Organized Conference Sessions

Farris, A. 2017. Supporting Climate Networks through Regional Adaptation Forums to Increase Adaptive Capacity. National Adaptation Forum. May 10, 2017. St. Paul, MN.

Farris, A. 2017. Understanding Drought and Its Impacts in the Carolinas. NC Water Resources Research Institute Annual Conference. March 15-16, 2017. Raleigh, NC.

Farris, A. 2017. Climate Implications for Water Resources. NC Water Resources Research Institute Annual Conference. March 15-16, 2017. Raleigh, NC.

Farris, A. 2016. Development of a Drought Early Warning System for the Carolinas. 2016 South Carolina Water Resources Conference. October 12-13, 2016. Columbia, SC.

Lackstrom, K. 2016. Climate Change and Water Resources in the Carolinas. 2016 South Carolina Water Resources Conference. October 12-13, 2016. Columbia, SC.

Tuttle, S. 2017. Inclusive Climate Adaptation & Resilience Building Working Group. National Adaptation Forum. May 11, 2017. St. Paul, MN.

Presentations

Allen, T., T. Crawford, & B. Montz, Multi-model Spatial Threats to Coastal Community Water Infrastructure. 39th Applied Geography Conference, October 28, 2016, Louisville, KY.

Allen, T.R. NOAA COCA Project Overview: Community-Wide Public Health Risk Assessment for Water. Hampton Roads Water Forum, September 14, 2016, Chesapeake, VA.

Allen, T.R. and Crawford, T.A. Multi-Hazard Flooding Risk Maps for Coastal Community Water Infrastructure. Coastal GeoTools Conference, February 9, 2016, Charleston, SC.

Allen, T.R. Sea Level Rise and Multi-Hazard Flooding Risks to Coastal Community Water Infrastructure. American Association of Geographers Annual Meeting, April 6, 2016, Boston, MA.

Burger, D., R. DeVoe, E. Fly, and M. Wilbert. Catalyzing Events Leading to the Organization of the Charleston Resilience Network. Panel Discussion. Carolinas Climate Resilience Conference, September 13, 2016, Columbia, SC.

Carbone, G., P. Gao, J. Lu. How extreme was the October 2015 precipitation event in South Carolina? Carolinas Climate Resilience Conference, September 14, 2016, Columbia, SC.

Carbone, G.J. 2017. Hydroclimate Extremes in the Carolinas. North Carolina Water Resources Research Institute Annual Conference, March 15, 2017, Raleigh, NC.

Carbone, G.J. A Hydroclimate Extremes Atlas for the Carolinas. South Carolina Water Resources Conference, October 13, 2016, Columbia, SC.

Dow, K. The Role of Scientists in Producing and Defending Evidence. Panel Discussion. American Association for the Advancement of Science, Forum on Science and Technology Policy, March 27-28, 2017, Washington, DC.

Dow, K. Vanishing Shorelines: Adapting to Sea-Level Rise in the Atlantic. Panel Discussion. American Association for the Advancement of Science, Forum on Science and Technology Policy, March 27-28, 2017, Washington, DC.

Dow, K. Who is your Audience? Panel Discussion. American Association for the Advancement of Science Annual Meeting, Communicating Science Seminar, February 16-20, 2017, Boston, MA.

Farris, A. Condition Monitoring: A New System for Drought Impacts Reporting through CoCoRaHS. WERA 1012: CoCoRaHS Annual Conference, May 17, 2017, Estes Park, CO.

Farris, A. Mapping Drought Monitoring Reports to Improve Access and Usability. North Carolina Water Resources Research Institute Annual Conference, March 15, 2017, Raleigh, NC.

Farris, A. CoCoRaHS Condition Monitoring. Florence Master Gardeners Meeting, November 21, 2016. Florence, SC.

Farris, A. CoCoRaHS Condition Monitoring Reports. North Carolina DMAC Assessment Process Training. Workshop organized by the State Climate Office of North Carolina and North Carolina Cooperative Extension, November 14, 2016, Raleigh, NC.

Farris, A., K. Lackstrom, K. Dow, J. Davis, D. Eckhardt, and S. Selvaraj. What Can Citizen Scientists Tell Us About Drought? Using the Community Collaborative Rain, Hail & Snow Network to Improve the Monitoring and Reporting of Drought Impacts in the Carolinas. 2016 South Carolina Water Resources Conference, October 13, 2016. Columbia, SC.

Fly, E. Climate Change Impacts in the Lowcountry. Donnelley Foundation Land Conservation Symposium, May 16, 2017, Charleston, SC.

Fly, E. Building Community Resilience to Water-Related Hazards in the Charleston, SC Region: A Charleston Resilience Network Initiative. National Planning Conference, May 6, 2017, New York City, NY.

Fly, E. Our Changing Climate: Regional Data, Trends, and Impacts for South Carolina. NOAA Climate Adaptation Training, January 25, 2017, Charleston, SC.

Fly, E. Past, Present, and Future: Reactive to Proactive Strategies for Adapting to Sea Level Rise in the Charleston Region. American Institute of Architects Resilience by Design, November 17, 2016, Charleston, SC.

Fly, E. Charleston Takes on Sea Level Rise: Strategies, Projects, Funding and Progress. League of Women Voters, November 14, 2016, Hilton Head Island, SC.

Fly, E. Knowing your audience: Fostering Climate Communication and Adaptation in the Carolinas. Georgia Climate Conference. November 3, 2016, Jekyll Island, GA.

Fly, E. The State of the Climate: Impacts for South Carolina's North Coast. The Nature Conservancy North Coast Resilience Summit, September 28, 2016, Georgetown, SC

Fly, E. Disaster Planning in the Face of a Changing Climate. American Association of Occupational Health Nurses Invited Webinar, September 14, 2016.

Fly, E. Community Leadership in Planning for Sea Level Rise: Beaufort/Port Royals Sea Level Rise Task Force. Carolinas Climate Resilience Conference, September 12, 2016. Charlotte, NC.

Fly, E. Our Changing Climate: Regional Data, Trends, and Impacts for South Carolina. NOAA Climate Stewards Workshop, August 2, 2016, Charleston, SC.

Fly, E. Addressing the Impacts of Weather and Climate Hazards in the Lowcountry. South Carolina Department of Health and Environmental Control: Healthcare Preparedness Coalition, July 7, 2016, Charleston, SC.

Fly, E. Stemming the Tide: Global Sea Level Change and Local Impacts in South Carolina. South Carolina Department of Natural Resources: Climate Teacher Workshop, June 19, 2016, Charleston, SC.

Gao, P., G.J. Carbone, and J. Lu. How extreme was the October 2015 precipitation event in South Carolina? South Carolina Water Resources Conference, October 13, 2016, Columbia, SC.

Green, C. and G. Carbone. Putting Climate in Context through Local Videos. Carolinas Climate Resilience Conference, September 13, 2016, Columbia, SC.

Hanks, A. Indexing Public Health Vulnerabilities to Coastal Water Infrastructure. Carolinas Climate Resilience Conference, September 13, 2016, Columbia, SC.

Konrad, C., J. McLeod, A. Ward, S. Smith, and A. Hirsch. The Southeast U.S. Drought of 2016 and Public Health Impacts of Wildfire Smoke. Climate Prediction Applications Science Workshop, May 2, 2017, Anchorage, AK.

Konrad, C. The Southeast U.S. Drought: 2016-2017. Webinar at the Southeast and Caribbean Team (SECART) Annual Meeting, February 1, 2017.

Konrad, C. Climate Highlights for the Southeast U.S. Webinar presentation for the Guest Expert Series, sponsored by the National Center for Environmental Information (NCEI), December 15, 2016.

Konrad, C. Climate Change in North Carolina. Great Decisions Speaker Series at Farrington Village, October 13, 2016, Chapel Hill, NC.

Konrad, C. Introduction to the Heat-Health Vulnerability Tool. Public Health Stakeholders Meeting, September 29, 2016, Elizabethtown, NC.

Konrad, C. Going to Extremes: Tropical Storms and Hurricanes. Carolinas Climate Resilience Conference, September 12, 2016, Charlotte, NC.

Konrad, C. The Climate of the Southeast U.S.: Geographic Patterns and Trends in Extreme Events. Webinar by the Community Collaborative Rain, Hail, & Snow Network (CoCoRaHS), July 14, 2016.

Lackstrom, K., A. Farris, and K. Dow. What can citizen scientists tell us about drought conditions and impacts? 71st Annual SEDAAG Meeting, November 21, 2016, Columbia, SC.

Lackstrom, K. 2016. Coastal and Wetland Ecosystems: Overview of Drought Indicators, Impacts, and Management Issues. DOI Southeast Climate Science Center Workshop "Ecological Drought – Impacts, Resistance, and Recovery", November 16-17, 2016, Raleigh, NC.

Lackstrom, K., K. Dow, A. Farris, B. Haywood, D. Chalcraft, C. Nolan, and D. Tufford. Drought and Coastal Ecosystems: An Assessment of Decision Maker Needs for Information. American Water Resources Association, 2016 Annual Water Resources Conference, November 14, 2016, Orlando, FL.

Lackstrom, K. Development of a Drought Early Warning System for the Coastal Carolinas: Session Introduction." 2016 South Carolina Water Resources Conference, October 13, 2016, Columbia, SC.

Lackstrom, K., G. Carbone, D. Tufford, and A. Patel. Climate and Water Resources in the Carolinas: Approaches to Applying Global Climate Change Information to Local & Regional Questions. 2016 South Carolina Water Resources Conference, October 13, 2016, Columbia, SC.

Lackstrom, K. Overview of the Coastal Carolinas DEWS Goals and Activities. NIDIS Coastal Carolinas Drought Early Warning System (DEWS) Meeting, June 2, 2016, Wilmington, NC.

Levine, N., N. Rubin, and T. Callahan. High Resolution Flood Modeling for Planning, Mitigation, and Response, Charleston, SC. 2017 Geological Society of America Southeastern Section Meeting, March 31, 2017, Richmond, VA.

Lu, J., G.J. Carbone, and P. Gao. Detrending Crop Yield Data for Spatial Visualization of Drought Impacts in the United States, 1895-2014. 71st Annual SEDAAG Meeting, November 21, 2016, Columbia, SC.

Patel, A. Climate Information for Long-Term Water Supply Planning: A Case Study with OWASA. North Carolina Water Resources Research Institute Annual Meeting, March 15, 2017, Raleigh, NC.

Patel, A. What can we say about implications of climate change for water supply planning? Invited Paper North Carolina American Water Works Association, Water Environment Association Annual Meeting, November 14-16, 2016, Raleigh, NC.

Patel, A. and G. Carbone. A Bottom-Up Approach for Assessing the Long-Term Reliability of Water Supply in a Changing Climate. South Carolina Water Resources Conference, October 13, 2016, Columbia, SC.

Patel, A., R. Rouse, and G. Carbone. Developing Information for Integration of Climate Change in Long-Term Water Supply Planning. Carolinas Climate Resilience Conference, September 13, 2016, Charlotte, NC.

Rouen, L. and P. Conrads. Using the Coastal Salinity Index for Monitoring Drought in the Carolinas. 2017 Georgia Water Resources Conference, April 19, 2017, Athens, GA.

Rouen, L. and P. Conrads. Using the Coastal Salinity Index for Monitoring Drought in the Carolinas. North Carolina Water Resources Research Institute Annual Conference, March 15, 2017, Raleigh, NC.

Shelley, D. C., P. Fettig, T. Thomas, C. Green, G. Carbone, and E. Jones. Lessons from Lessons: Making Climate Impact Videos with 9th Grade World Geography Students. Carolinas Climate Resilience Conference, September 14, 2016, Columbia, SC.

Ward, A. Heat Health in Native American Communities in North Carolina. NC American Indian Health Board Meeting, April 21, 2017, Chapel Hill, NC

Ward, A. Incorporating Stakeholder Feedback into Tool Development. Climate-Health Conference, East Carolina University, March 23, 2017, Greenville, NC.

Ward, A. Engaging Communities in Tool Development: Heat Health Vulnerability Tool. Heat-Health Panel, 13th Annual One Medicine Symposium, December 8, 2016, Durham, NC.

Ward, A. Heat-Health Vulnerability Tool: Incorporating Community Stakeholder Feedback into Tool Development. 71st Annual SEDAAG Meeting, November 21, 2016, Columbia, SC.

Ward, A. Heat-Health Vulnerability Tool. Carolinas Climate Resilience Conference, September 13, 2016, Charlotte, NC.

Ward, A. Heat-Health Vulnerability Tool. Annual Heat Meeting, State Emergency Operations Center, August 19, 2016, Raleigh, NC.

Ward, R. Overview of Coastal Carolinas Drought. NIDIS Coastal Carolinas Drought Early Warning System (DEWS) Meeting, June 2, 2016, Wilmington, NC.

Whitehead, J., E. Fly, T. Allen, T. Crawford, A. Hanks, G. Kearney, S. Lovelace, and B. Montz. Developing Exercises to Improve Planning for Public Health Impacts and Community Water Infrastructure from Coastal Hazards. NC Water Resources Research Institute Annual Meeting, March 15, 2017, Raleigh, NC.

Posters

Allen, T.R. Spatial Modeling of Multi-Hazard Flooding Risks to Coastal Community Water Infrastructure. 71st Annual SEDAAG Meeting, November 21, 2016, Columbia, SC.

Lu, J., G. Carbone, and P. Gao. Spatial Visualization of Historical Drought Impact on Agriculture in North and South Carolina. Carolinas Climate Resilience Conference, September 14, 2016, Charlotte, NC.

Patel, A. and G. Carbone. Producing Contextual Climate Change Information for Strategic Water Supply Planning. Annual Meeting of American Association of Geographers, April 5-9, 2017, Boston, MA.

Reports

Farris, A. and E. Davis. 2016. Carolinas Climate Resilience Conference: Final Report and Summary of Evaluation Results, September 12 – 14, 2016, Charlotte, NC, 17 pp.

Lackstrom, K. and A. Farris. 2016. Coastal Carolinas Drought Early Warning System Meeting Summary Report, June 2, 2016, Wilmington, NC, 22 pp.

Tuttle, S., N. Glover, J. Patterson, D. Purifoy, and L. Woodberry. 2017. Inclusive Climate Adaptation and Resilience Building: National Adaptation Forum Session Report, May 9 – 11, 2017, St. Paul, MN, 12 pp.

Theses and Dissertations

Landis, Z. 2017. The Community Rating System: Assessing Indicators of Community Performance, a Daysmetric and SOVI Approach. Masters Project, Department of Geography, University of South Carolina.

Selvaraj, S. 2016. Assessing the differential vulnerability of public transit users to nuisance flooding in the Charleston, SC area. Masters Project, Department of Geography, University of South Carolina.

Videos

Green. C. 2016. Flying Ahead of Trouble Waters. https://www.youtube.com/watch?v=6DS9bWMsBNM

Green. C. 2016. Supplying Stakeholders on the Savannah. https://www.youtube.com/watch?v=pM9XiGKcnJs

Green. C. 2016. Tackling Water in a Tourist Town. https://www.youtube.com/watch?v=9UZP-BG6GAY

Green. C. 2016. Finding Signs of Rising Seas Along the Southern Coast. https://www.youtube.com/watch?v=nbfpLTaiIuU

Web-based Tools

Carolinas Precipitation Patterns & Probabilities Atlas. 2016. Developed by Gregory Carbone and Karen Beidel, CISA, University of South Carolina. http://www.cisa.sc.edu/atlas/

Condition Monitoring Web Map (Version 2.0). 2017. Developed by David Eckhardt and Eleanor Davis, CISA, University of South Carolina. http://www.cisa.sc.edu/map/

Convergence Website. 2017. Developed by Ashley Ward, CISA, University of North Carolina, Chapel Hill. http://convergence.unc.edu/

Heat Health Vulnerability Tool (Version 2.0). 2017. Developed by the State Climate Office of North Carolina and the Southeast Regional Climate Center, University of North Carolina at Chapel Hill. http://convergence.unc.edu/tools/heat/