

# Carolinas Climate Connection

Carolinas Integrated Sciences & Assessments

Integrating Climate Science and Resource Management in the Carolinas

## CISA Annual Report Highlights

May 1, 2013 - April 30, 2014

Each year CISA produces an annual report as a record of the year's research and accomplishments. This edition of the Carolinas Climate Connection provides highlights from that report which covers the period May 2013 through May 2014. To view a copy of the full report, visit us online at: [www.cisa.sc.edu](http://www.cisa.sc.edu).

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## Get to know your RISA

Based out of the Department of Geography at the University of South Carolina, the [Carolinas Integrated Sciences & Assessments](#) (CISA) program is 1 of 11 NOAA-funded [Regional Integrated Science & Assessments](#) (RISA) teams, working to integrate climate science into decision-making processes and improve society's ability to respond to climatic events and stresses. CISA conducts applied climate research in collaboration with a wide range of stakeholders across the Carolinas. Our work includes cross-cutting activities that seek to advance scientific understanding of climate and hydrological processes in the Carolinas, improve the assessment of climate-related vulnerabilities and impacts, and provide timely and relevant information and tools for decision makers.

## 2013-2014 CISA Team Members

### Principal Investigators

Kirstin Dow, University of South Carolina  
 Greg Carbone, University of South Carolina  
 Elizabeth Fly, CISA and South Carolina Sea Grant Consortium  
 Chip Konrad, The University of North Carolina at Chapel Hill & SE Regional Climate Center  
 Dan Tufford, University of South Carolina

### Collaborating Investigators

Tom Allen, East Carolina University  
 Ryan Boyles, State Climate Office of North Carolina  
 Dave Chalcraft, East Carolina University  
 Michael Childress, Clemson University  
 Paul Conrads, South Carolina USGS Water Science Center  
 Chris Fuhrmann, Southeast Regional Climate Center  
 John King, North Carolina State University  
 Hope Mizzell, South Carolina State Climatology Office  
 Burrell Montz, East Carolina University  
 Jan Moore, NOAA Center for Coastal Environmental Health and Biomolecular Research  
 Geoff Scott, University of South Carolina  
 Seth Tuler, Social and Environmental Research Institute  
 Tom Webler, Social and Environmental Research Institute  
 Jessica Whitehead, North Carolina Sea Grant  
 Karin Yeatts, The University of North Carolina at Chapel Hill

### Research and Support Staff

Research Associates: Peng Gao, Kirsten Lackstrom, Jordan McLeod, Vidya Samadi  
 Climate Outreach Specialist: Amanda Brennan  
 Research Assistants: Ivetta Abramyan, Sean Bath, Chase Brown, Janae Davis, Reem Deeb, Bonnie Epstein, Benjamin Haywood, Maggie Kovach, Steven Lippmann, Junyu Lu, Zach Oyer, Aashka Patel, Kim Rodgers, Katie Sayre, Sumi Selvaraj

## Upcoming Events

### 9th Annual Regional Stormwater Conference

Charleston, SC  
 October 8-10, 2014

### SC Water Resources Conference

Columbia, SC  
 October 15-16, 2014

### NC Beach, Inlet, and Waterway Association Annual Conference

Wrightsville Beach, NC  
 November 17-18, 2014

## Connect with CISA

In addition to our quarterly newsletter, CISA also maintains the [Carolinas Climate Listserv](#) in order to share up-to-date information about climate research, upcoming events, funding opportunities, and other relevant news.

Contact us if you would like to subscribe to the listserv or to request additional information about our projects and resources.



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# CISA Annual Highlights 2013 - 2014

## Climate and Public Health Research

CISA's health work investigates the links between climate and human health. Projects have focused on sampling in North and South Carolina estuaries for *Vibrio* and assessing climate impacts to air quality throughout North Carolina. Ongoing work by the Southeast Regional Climate Center and NC State Climate Office to develop a web-based public health toolbox will help to inform a heat vulnerability assessment.

### Assessing Heat Stress Vulnerability

Team Members: Konrad, Fuhrmann, Kovach

Goals of this research are to 1) identify climate-public health vulnerabilities across different regions (e.g. coastal plain, piedmont, mountains) and populations (e.g. rural vs. urban) of North Carolina and 2) develop empirical relationships that can be exploited to build tools that translate recent, current, and predicted weather/climate conditions across NC into useful information regarding the probability of public health emergencies (e.g. spikes in heat related morbidity/mortality). Current work focuses on the temporal and spatial patterns in heat morbidity across NC using a unique emergency room admission database, NC DETECT. Efforts are underway to identify temperature thresholds across which heat morbidity rates increase markedly. Thresholds are being calculated for different demographic groups (e.g. teenagers vs. elderly) across various rural and urban regions of the state. Findings to date indicate that the highest rates of heat-related admissions are found in rural areas where labor-intensive crops are grown, rather than urban areas, which are commonly assumed to have greater risk due to the urban heat island effect.

### Climate Change Impacts of Air Pollution on Morbidity in Vulnerable Populations

Team Members: Yeatts, Lippmann

Researchers conducted a health impact assessment of future climate change-related ozone morbidity for North Carolina in 2050. Efforts focused on identifying impacts among vulnerable populations, such as the elderly, children, and those with chronic cardiopulmonary diseases. Stakeholders expressed an interest in using the study results to help educate the public and their constituents in order to inform and guide future local public health planning and adaptation efforts. For example, Piedmont Together would like to use results to demonstrate what the air quality will be like in the Piedmont of North Carolina in 2050.

### Assessing the Impacts of Climate Variability on Water Quality Conditions and *Vibrio* in South Carolina Estuaries

Team Members: Tufford, Dow, Deeb, Moore, Scott

CISA funded a collaboration with the NOAA Center for Coastal Environmental Health and Biomolecular Research (CCEHBR) to quantify the occurrence, if any, of the marine bacteria *Vibrio vulnificus* and *V. parahaemolyticus* in the Waccamaw River and to evaluate empirical relationships with potential environmental drivers such as temperature and salinity. These bacteria pose health threats through both wound infection and shellfish ingestion. Information about the occurrence, abundance, and spatial and temporal dynamics of *Vibrio* spp. is therefore important for water recreation, commercial and recreational shellfish harvesters, and public health officials.

Monthly sampling of surface and bottom water from 9 sites in Winyah Bay was conducted over the period April-October 2012. Analysis of samples revealed that *Vibrio vulnificus* counts were the highest when salinity ranged between 5 and 20 ppt, within the salinity range of most saltwater estuaries. *Vibrio parahaemolyticus* did not show a clear pattern with salinity, indicating the possibility of other factors that interact to control its occurrence and abundance. Turbidity showed a positive association with both bacteria, while temperature values during sampling were within *Vibrio*'s optimal range for growth and seemed to have a lesser effect. The PRISM2 model, which integrates predictions of future streamflow and sea level in an artificial neural network model, was used to estimate future conductivity levels (a proxy for salinity) and the potential for increased *Vibrio* occurrence in the Winyah Bay estuary. Results show that the increased relative risks of optimum *Vibrio* growth based on specific conductance will increase up to 36X depending on location and range of sea level rise. These increased periods of optimal growth conditions for *Vibrios* may result in increased risk for swimmers and shellfish consumers, if virulent forms occur with more regularity.



Oyster bed in Murrellsville, SC  
Photo by: Doug DuCen

Oysters found in tidal creeks similar to the one shown above can carry *Vibrio* bacteria which is a public health threat when ingested or when the bacteria come into contact with open wounds.

# CISA Annual Highlights 2013 - 2014

## Collaboration with the National Integrated Drought Information System (NIDIS)

CISA's current drought work builds on stakeholder-identified needs and recommendations from the 2012 NIDIS Carolinas Drought Early Warning System Scoping Workshop. Investigations of the full range of coastal drought impacts and low flow vulnerabilities are needed to inform management and drought early warning systems. Work to date has focused on efforts to improve our understanding of coastal drought impacts and how improved monitoring might be incorporated into drought planning and preparedness. Continued efforts will build on this knowledge. Ongoing projects are described in the bulleted list below.

### *Improving Understanding of Drought Impacts in Coastal Ecosystems through Stakeholder Interviews*

**Team Members:** Dow, Lackstrom, Brennan, Davis, Haywood, Patel, Rodgers, Sayre

CISA team members conducted interviews in the Beaufort County (SC) and Carteret County (NC) areas with individuals involved in commercial and recreational fishing, land and refuge management, outdoor recreation, and non-profit conservation. The goal of these interviews was to improve understanding of "ecological drought" (that is, a water deficiency causing stress to plants, animals, and ecosystems), the associated socioeconomic impacts, and decision makers' needs for drought information or resources in the coastal Carolinas. Although some findings vary by sector and location, key themes which emerged from the interviews are summarized in the table below. These findings will be used to inform additional pilot project efforts in considering how to develop a drought early warning information system that is most useful to these communities.

Coastal Drought Stakeholder Interview Findings
<ul style="list-style-type: none"><li>It is not a shortage of rainfall per se that leads to coastal ecological drought, but multiple factors including variable precipitation patterns, freshwater inflows from upstream, and tidal regimes. Key concerns focused on water quality conditions, particularly salinity levels and fluctuations, and the availability of freshwater at certain times of the year to meet the needs of animals, vegetation, and habitats.</li></ul>
<ul style="list-style-type: none"><li>Fluctuating salinity levels affect the movement and location of many aquatic species, which in turn can affect their accessibility to fishers. Blue crabs and shrimp, and the people who fish for those species, were most affected by these fluctuations. Interviewees working in managed lands or refuges expressed concerns about the effects of drought on managed ecological areas (e.g. waterfowl impoundments), vegetation (e.g. submerged aquatic vegetation for impoundments and fire fuel), and soil conditions. Adverse conditions can increase fire risks as well as make impoundments unsuitable for waterfowl or fish (thereby limiting recreational use of these areas).</li></ul>
<ul style="list-style-type: none"><li>In general, interviewees did not report using formal sources of drought information on a regular basis. Individuals involved in fishing or recreation consider information related to weather, tides, salinity, fishing conditions, financial costs, and regulations, as well as their personal observations and local knowledge about coastal resources. Likewise, land and refuge managers also use a range of locale-specific hydrological, salinity, and other environmental information to make management decisions.</li></ul>
<ul style="list-style-type: none"><li>With both the timing and duration of extreme precipitation events (i.e. too little or too much rain) of importance, interviewees indicated a need for: better baseline data so they can improve understanding of what is "normal" (e.g. frequency of drought events, recovery periods); research and monitoring efforts that would provide them with better information about the ecological indicators of drought (e.g. the biological impacts, thresholds, and responses to extreme events); and continued work to evaluate the types of early warnings and forecasts that might be useful for seasonal and annual decisions.</li></ul>

### *Ongoing work to support the NIDIS Carolinas Drought Early Warning Pilot Program*

CISA team members are working on a number of different projects to support the development of a drought early warning information system in the coastal region of the Carolinas. Projects include:

- implementation of a **citizen science volunteer effort** to increase drought impacts monitoring using tools available through the Community Collaborative Rain, Hail and Snow (CoCoRaHS) network (Brennan, Davis, Dow, Lackstrom, Sayre, Selvaraj)
- development of an '**Atlas of Hydroclimate Extremes**' for the Carolinas to include information on related impacts, connecting climate variability to management and coping decisions (Carbone, Dow, Fly, Konrad, McLeod, Tufford)
- development of a **coastal drought index** which captures movement of the freshwater-saltwater interface in surface water bodies along the coast using real-time salinity data (Conrads)
- development of **ecological drought indicators** for the coastal regions of the Carolinas and assessment of these indicators using the coastal drought index (Chalcraft, Tufford)
- assessment of existing drought indicators to determine those which best represent **coastal zone fire risk** levels (Boyles)
- development of a decision support tool to **forecast SC blue crab landings**, using information about current and projected changes in freshwater discharge and salinity (Childress)

# CISA Annual Highlights 2013 - 2014

## Supporting Coastal Climate Adaptation Efforts

The purpose of CISA's coastal climate work is to provide tailored, decision-relevant information to coastal communities and decision makers about the implications of climate variability and change and to support identification of strategies to increase resilience to those impacts. Team members work directly with communities to address needs related to waterfront management, sea level rise, saltwater intrusion, natural hazards, and community planning.

### *Climate Change Impacts on Water Infrastructure*

**Team Members:** Allen, Montz, Oyer

This project addresses the potential vulnerability of municipal water and wastewater infrastructure to coastal hazards. Study sites are located in the North Carolina coastal communities of Manteo, New Bern, and Plymouth. The team produced a series of detailed maps that include infrastructure location as well as the potential sea level rise, storm surge, and riverine flooding risks to those sites for the three communities. Risks to water lines and pump stations were included in the analysis based on advice from community planners. Participating communities are recipients of an aggregated benefit because this project allows multiple jurisdictions to be seamlessly assessed and a range of vulnerabilities visualized and compared; a benefit which would not be realized through individual community assessments. Maps and graphics will be provided to NC Sea Grant for future activities to communicate climate change risks to coastal communities. Also, the data layers (e.g. floodplain maps, SLOSH MOMs, and SLR scenarios) generated for the project will be published in the *NC Coastal Atlas*, a collaborative effort to provide public access to geospatial data, visualization tools, and thematic maps focused on coastal resources and hazards.

### *Coastal Ecosystem Resilience to Sea Level Rise*

**Team Members:** King, Brown

This project will quantify the carbon (C) contained in vegetation and soils of the predominant ecosystems that occur at Alligator River National Wildlife Refuge (ANWR) and quantify thresholds of salinity and hydro-period (number of days per year the soil is flooded) resulting in transition from one ecosystem type to another. Focus is being placed on the effects of historical ditching and drainage on soil water dynamics and salinity, quantifying the role of extreme events such as flood tides and hurricanes. The information gathered will be combined with a GIS-remote sensing analysis of ecosystem vulnerability (to transition) across the Refuge, which will allow managers to implement mitigation procedures (e.g. planting flood tolerant tree species) or adapt (e.g. start managing for future conditions of wildlife habitat). A public outreach event is scheduled for December 5, 2014 at ARNWR headquarters on Roanoke Island, NC to discuss the science of the CISA/Refuge project and solicit input from local constituents.

### *Engaging Local Stakeholders in Climate-Resilient Planning in the Coastal Carolinas*

**Team Members:** Fly, Whitehead, Bath

CISA team members are working to write a plan for priority actions to update planning and form-based codes in order to encourage climate resilience in Beaufort County, SC. This has been accomplished through stakeholder interviews and workshops using the *Vulnerability, Consequences and Adaptation Planning Scenarios (VCAPS)* process. A report containing recommended adaptation actions is being developed in partnership with the Beaufort County (SC) Planning Department with input from the public. While this project was originally intended to help inform Beaufort County's update of its Comprehensive Plan, several other opportunities have arisen from this work. For example, the County's Disaster Recovery planner has asked for help in updating the Disaster Recovery Plan with sea level rise projections and the County is creating a list of Capital Projects they will prioritize for funding. There are also opportunities for the project to serve as a demonstration for other communities in North and South Carolina.

**Top Right:** CISA and SC Sea Grant coastal climate extension specialist Liz Fly shares information with citizens in Beaufort County, SC about adaptation strategies to address potential vulnerabilities to sea level rise in the county. Two public workshops were held to allow stakeholders an opportunity to provide feedback on the list of adaptation strategies identified by focus groups in the county.

**Bottom Right:** Stakeholders offered suggestions on prioritization of existing strategies as well as other possible strategies to add to the list.



# CISA Annual Highlights 2013 - 2014

## Working with Decision Makers to Produce Locally Relevant Climate Information

Decision makers and stakeholders in the region are showing increasing interest in learning how climate information can be made applicable and relevant to various planning processes. The two new projects described below showcase work CISA researchers have conducted over the past year to produce tailored products to meet the specific needs of stakeholders interested in potential climate change impacts.

### Generation of Climate Change Scenarios Appropriate for Low Impact Design

Team Members: Carbone, Gao, Rodgers

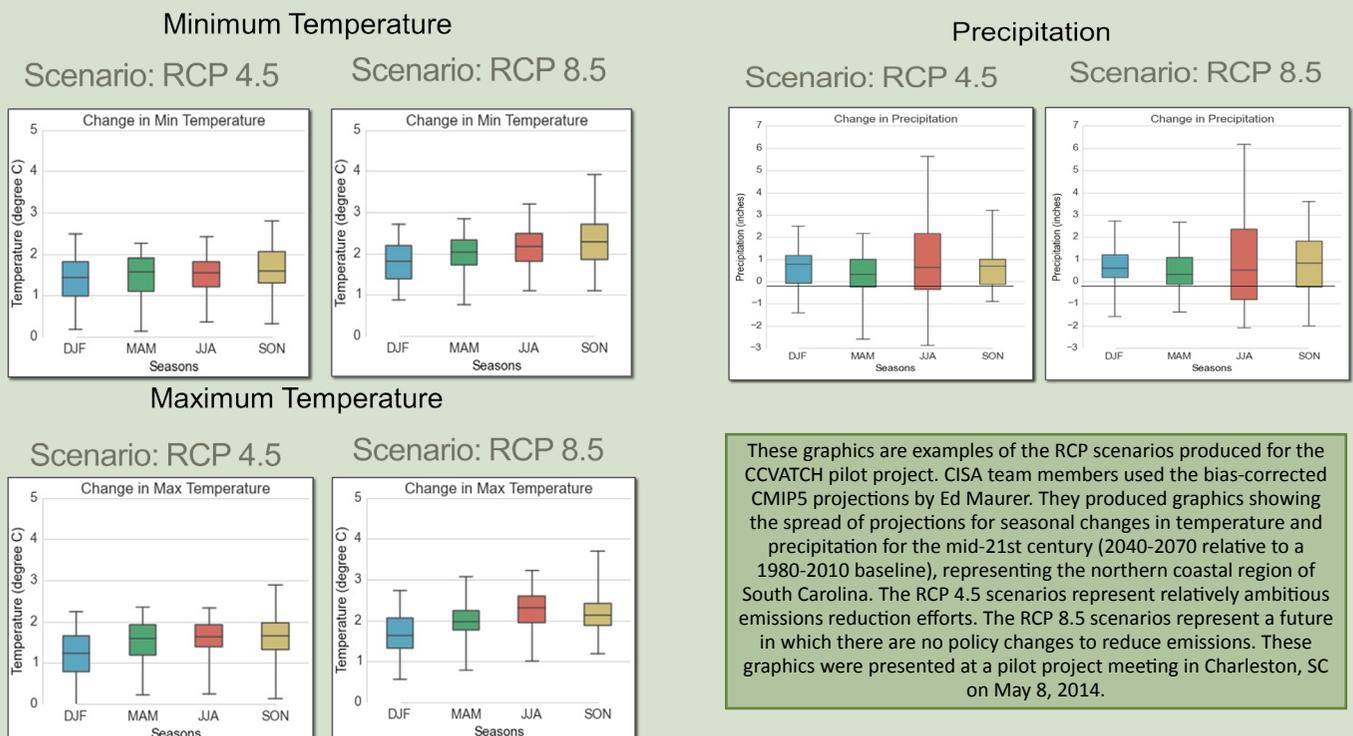
CISA provided technical support to the ACE Basin and North Inlet-Winyah Bay National Estuarine Research Reserves (NERRS), the Center for Watershed Protection, and South Carolina Sea Grant Consortium, who were funded through a NERRS Science Collaborative grant to develop a *Low Impact Development (LID) Manual for Coastal South Carolina*. From a stormwater management perspective, LID practices have been promoted as an effective way for reducing runoff from urbanized landscapes and reducing water quality contamination. Though this practice emerged for different needs, it has in more recent years also been suggested as an adaptive management technique for dealing with the uncertain and variable impacts of climate change on localized precipitation regimes. This project is one of the first instances, however, where a group is specifically concerned with ensuring that LID practices can withstand potential climate changes over the expected 30-50 year lifetime of LID site designs. CISA team members provided information to aid in understanding of the variability, trends, and potential future changes in precipitation in a manner that is particularly important for stormwater/LID engineering practices and design.

### NERRS Climate Change Vulnerability Assessment Tool for Coastal Habitats

Team Members: Carbone, Patel

The goal of this effort is to provide regionally-specific climate change information for the *Climate Change Vulnerability Assessment Tool for Coastal Habitats (CCVATCH)*. This tool is being developed by several members of the National Estuarine Research Reserve System (NERRS). CCVATCH is designed to assess relative habitat vulnerabilities under a given set of climate change stressors. CISA researchers worked with the pilot project coordinators to understand the type of information they needed to assess habitat vulnerabilities under a given set of climate change stressors using CCVATCH. This communication drove decisions about the choice of climate projections datasets, spatial and temporal scales of aggregation, and the graphical format for communicating the results.

Valuable insights regarding the usefulness and application of downscaled climate information emerged through this effort. The project illustrates that decision makers may not always require highly refined or localized climate information, particularly in the early stages of considering climate change vulnerability. While it may be easy to assume that the plethora of publicly available climate data and tools would meet the information needs in such cases, this is not always true. Team members learned that NERR resource managers benefited from guidance on choosing the source of information as well as how to use it. In the end, climate projection data were used to produce information specifically tailored for the vulnerability assessment tool.



These graphics are examples of the RCP scenarios produced for the CCVATCH pilot project. CISA team members used the bias-corrected CMIP5 projections by Ed Maurer. They produced graphics showing the spread of projections for seasonal changes in temperature and precipitation for the mid-21st century (2040-2070 relative to a 1980-2010 baseline), representing the northern coastal region of South Carolina. The RCP 4.5 scenarios represent relatively ambitious emissions reduction efforts. The RCP 8.5 scenarios represent a future in which there are no policy changes to reduce emissions. These graphics were presented at a pilot project meeting in Charleston, SC on May 8, 2014.

# CISA Annual Highlights 2013 - 2014

## Climate Communications & Outreach

CISA is a regional resource for climate-related news and information for a variety of stakeholders throughout the Carolinas. CISA works to support state and local adaptation projects and capacity-building by providing opportunities for information exchange and translating scientific data into useable formats for decision makers and the public. CISA achieves this goal through specific communications products such as the quarterly newsletter, listserv, and website as well as through targeted projects with various stakeholder groups.

## Carolinas Climate Resilience Conference

### *Fostering a Network of Climate Adaptation Practitioners*

Team Members: Brennan, Dow, Lackstrom

CISA hosted the first Carolinas Climate Resilience Conference April 28-29, 2014, in Charlotte, NC. The event, which drew nearly 200 attendees, included over 100 presentations on topics ranging from water resources management and local adaptation actions to climate model downscaling and climate trends in the Carolinas. Kathy Jacobs, former director of the National Climate Assessment, gave the keynote address providing an overview of the 3rd National Climate Assessment and findings for the Southeast.

The conference drew press attention as well with an article published in *The Charlotte Observer* on the 2nd day of the event. All posters and presentations are available on the [conference website](#). Full conference details, including results of the participant evaluation survey, are available in the [final report](#). The next Carolinas Climate Resilience Conference will take place in 2016.

### *Making Climate Science Accessible*

Team Members: Boyles, Carbone, Konrad, Mizzell

In order to provide opportunities for conference attendees to interact with climatologists and other climate experts, several sessions were organized to share information on current climate in the Carolinas, climate variability, climate modeling and downscaling, and anticipated changes in regional climate. Sessions included “Moving from Global to Local: What Regional Climate Models Can Tell Us”, “Carolina Connections: Bringing National Climate Assessment Findings Home”, and “What’s Up with Strange Weather? Climate Variability and Extremes” during which climatologists discussed events such as the winter storms earlier in the year and how those events compared to historical climate variability in the Carolinas. Copies of these and other presentations can be found on the [Speakers page](#) of the conference website.



**Top Left:** Christine Avenarius (East Carolina University) presents on her work to understand perceptions about climate in the Outer Banks during the Climate Communications session

**Bottom Left:** Attendees discuss poster presentations during the networking reception.

**Above:** Kathy Jacobs, former director of the National Climate Assessment, gives the keynote address.