



PROJECT PROGRESS REPORT
1 September 2011 – 31 May 2012

Award

Carolinas Integrated Sciences & Assessments (NA11OAR4310148)

1. TEAM MEMBERS

Principal Investigators

Greg Carbone (University of South Carolina)

Kirstin Dow (University of South Carolina)

Chip Konrad (University of North Carolina-Chapel Hill, Southeast Regional Climate Center)

Dan Tufford (University of South Carolina)

Jessica Whitehead (North Carolina Sea Grant, South Carolina Sea Grant Consortium)

Collaborating Investigators

Ryan Boyles (State Climate Office of North Carolina)

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 (NOAA Center for Coastal Environmental Health and Biomolecular Research)

Seth Tuler (Social and Environmental Research Institute)

Thomas Webler (Social and Environmental Research Institute)

Research and Support Staff (University of South Carolina)

Research Associates: Kirsten Lackstrom, Jinyoung Rhee, Vidya Samadi

Climate Outreach Specialist: Ashley Brosius

Research Assistants: Ivetta Abramyan, Amanda Brennan, Dylan Foster, Peng Gao, Benjamin Haywood, Erik Kabela, Nathan Kettle, Aashka Patel

2. FOCUS AREAS

CISA conducts applied climate research in collaboration with a wide range of water and coastal stakeholders across the Carolinas. CISA's work includes several 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.

This progress report details activities during the first year of funding received for 2011-2016. CISA has continued and expanded its work on drought, watershed/climate modeling, and coastal climate. Year 1 activities related to these core focus areas have involved disseminating information about CISA's research and projects to our stakeholders, fostering existing and building new stakeholder relationships, and meeting and working with different decision makers/stakeholders to plan and implement new projects.

In addition, increased funding levels provided through the new award have allowed us to extend our science and outreach activities to include two new focus areas – health and adaptation – and to expand our research partnerships. For example, Chip Konrad of the Southeast Regional Climate Center (located at UNC-CH) is a CISA principal investigator and serves as the lead for health projects. Other new collaborators are located at the NOAA Center for Coastal Environmental Health and Biomolecular Research (CCEHBR) located in Charleston, SC, and at East Carolina University in Greenville, NC.

3. RESEARCH FINDINGS

As of June 2012, the new research efforts we initiated under this funding cycle have not yet resulted in new findings. Research findings from previous efforts are reported under NOAA grant number NA06OAR4310007.

4. ACCOMPLISHMENTS

Core Office

CISA added two new positions to its core office at the University of South Carolina. Ashley Brosius, Climate Outreach Specialist, provides information about climate and CISA’s projects to decision makers. Vidya Samadi, post-doctoral researcher, is working on the “Integrating Regional Downscaling and Hydrological Models” project.

Climate Communications and Outreach

CISA has expanded its outreach and communications capacity by hiring a full-time Climate Outreach Specialist (Ashley Brosius). This position was established to enhance CISA’s ability to support state and local adaptation projects by providing opportunities for information exchange, translating scientific data into a useable format for decision-makers and the public (e.g. fact sheets, newsletters), and integrating local information needs into tools and products. In Year 1, Brosius has attended workshops and conferences organized by regional stakeholders and organizations, initiated projects to communicate climate information to decision makers, and worked with CISA PIs to disseminate research and project findings.

Principal Investigator Planning Meeting

The PIs and full-time staff (Ashley Brosius, Kirsten Lackstrom) participated in an inaugural CISA PI planning meeting in Columbia, SC, on October 20, 2012. The purpose of the meeting was for the PIs to update the group on research and project progress, discuss outreach and communications responsibilities and strategies, and develop plans for implementing new projects and partnerships with regional stakeholders.

CISA Advisory Committee

The CISA Advisory Committee met on March 14, 2012 in Charleston, SC. The purpose of the Committee is to provide guidance to the CISA PIs and staff about developing regional collaborations, identifying and addressing key decision maker needs in the Carolinas, and implementing new projects. Members include Jeff Allen (Clemson, SC Water Resources Center), Margaret Davidson (NOAA Coastal Services Center), Braxton Davis (NC Division of Coastal Management), Rick DeVoe (SC Sea Grant Consortium), Jerry McMahon (DOI Southeast

Climate Science Center), Tim Owen (NCDC), Linda Rimer (EPA Region 4), David Stoney (Kitchen Table Climate Study Group, McClellanville, SC), Lauren Thie (NC Division of Public Health), Mike Voiland (NC Sea Grant, Water Resources Research Institute), and Ellen Mecray (NOAA Regional Climate Services Director-Eastern Region, ex officio).

Minigrant Program

A significant addition to the CISA program, and funded in the new award, is the “CISA Mini-grant Program.” This program is intended to provide CISA a flexible mechanism to support other climate- and decision-relevant research and engagement in the Carolinas. During Year 1 CISA developed – and began implementation of – a plan for the Minigrant Program. The Call for Proposals was issued on June 4, 2012, with project proposals due on July 27, 2012. We have received 20 letters of intent from across both states. We expect to fund up to three new projects beginning in January 2013.

Stakeholder Interactions and Presentations

The team participated in over 40 presentations, trainings, and other stakeholder engagement activities. Audiences ranged from education and outreach communities, to agencies, academics, and stakeholders.

5. RESEARCH PROJECTS AND COLLABORATIONS IN-PROGRESS

5.1 DROUGHT

Our drought work seeks to improve monitoring methods, to develop a more comprehensive understanding of regional impacts, and to assess drought planning and early warning needs.

5.1.1 Implementation of a Drought Mapping Tool in the Eastern United States (Carbone, Rhee, Dow)

Partners: Northeast Regional Climate Center (A. DeGaetano, B. Noon, K. Eggleston), Southeast Regional Climate Center

Abstract: The Carolinas Dynamic Drought Index Tool (DDIT) provides a prototype that allows the display of multiple drought indices for different time scales and across user-specified regions. Project goals include expanding the coverage of the tool from the Carolinas to the states served by the Northeast and Southeast Regional Climate Centers, integrating the tool with the stable, near-real time Applied Climate Information System (ACIS) database, and adjusting the interface and functionality of the tool to ongoing user response.

Progress and Results: Year 1 activities include building on the DDIT’s monitoring capability by testing its use with new precipitation products, including gage-calibrated radar precipitation estimates. These data, produced at 4x4 km grid cells that match the current resolution, could produce more reliable precipitation estimates at higher resolution than existing interpolation methods. These activities are part of a collaborative project with the NC State Climatology Office (see below).

Leveraged Funding Source

- “Implementation of a drought mapping tool in the eastern United States”. Carbone, G.J., A. DeGaetano, K. Dow, H. Mizzell, J. Rhee. NOAA TRACS. September 2007. 1 May 2008 – 30 April 2012. \$249,570.

Stakeholder Interactions and Presentations

- Brosius, A. 2012. “Tools and Research to Improve the Characterization of Drought and Understanding of Impacts on Water and Ecological Resources.” Poster presented at the 14th Annual Water Resources Research Institute Conference, Raleigh, NC, March 27-28, 2012.
- Carbone, G. J. 2012. “Improving the characterization of drought and understanding of impacts on water and ecological resources.” Invited presentation at the 2012 NOAA in the Carolinas Conference: Water Resources and Resiliency, Fort Johnson, SC, March 15-16, 2012.

5.1.2. Drought Sensitivity Testing (Boyles)

Partners: SERCC (C. Konrad), Texas A&M University (J. Nielsen-Gammon), Purdue University (D. Niyogi)

Abstract: The State Climate Office of North Carolina is partnering with CISA to test the sensitivity of the DDIT with a variety of new data sets. These include high-resolution data sets not currently used, long-lead forecast information, and radar-based precipitation estimates. Activities include: providing access to surface and ground water data sets to enhance the spatial resolution and range of the DDIT’s drought indicators, developing methods to operationalize the DDIT’s use of long-lead forecast data, and using research on radar-based SPI estimates to evaluate the methods and if appropriate make radar-based SPI available for the DDIT.

Progress and Results: NCSU has worked with TAMU on technology and methods transfer. A graduate student was recruited to help develop software for automation and visualization. NCSU researchers visited TAMU in October 2011 to learn the methods and discuss implementation strategies and technical challenges. NCSU has made progress on drought calculations including:

- Finding stations and associated metadata for desired locations;
- For a given station, querying for all available precipitation data;
- Parsing through precipitation data, calculating precipitation accumulations for various monthly timescales (1-month, 2-month, 3-month,...,36-month) - the function that does this is flexible and can be used later in the project to calculate sub-monthly timescale accumulations;
- Calculating annual sample L-moment ratios for each station;
- Calculating L-moment ratios for each date for each accumulation period for each station;
- Determining station characteristics, such as ratio of minimum 2-month accumulated precipitation to maximum 2-month accumulated precipitation and months with maximum/minimum precipitation for use later in clustering;
- Station clustering using the Hoskings FORTRAN code base as reference.

Leveraged Funding Source

- “Development of a High-Resolution Drought Trigger Tool (HiRDTT) for the United States” USDA/NIFA/AFRI (Subcontract from Texas A&M University) \$116,424, Dec 2012 – Nov 2013.

5.1.3. Advancing Regional and Local Capacity to Cope with Drought (Dow, Tufford, Lackstrom, Brosius)

Partners: National Integrated Drought Information System (NIDIS), NC and SC State Climate Offices

Abstract: We engage with a range of stakeholders to determine their decision-support needs, prioritize and initiate projects, develop ways to transfer tools and information to stakeholders, and identify opportunities and regional activities through which NIDIS can support those needs.

Progress and Results: In Year 1 we have continued several projects to advance regional and local capacity to cope with drought. These projects center on understanding drought impacts on social and environmental systems currently under-represented in regional drought assessments, specifically coastal ecosystems and indigenous people.

Collaboration with NIDIS: Scoping Activities and Planning to Develop a Drought Early Warning System in the Carolinas. We are collaborating with NIDIS to advance drought preparedness and develop an Early Warning System pilot. The project’s intended focus will be coastal ecosystems. CISA activities have included the following:

- Attending relevant water resources and drought planning meetings in the region, interacting with decision makers and decision maker networks, and conducting research to increase understanding of impacts and vulnerability of coastal communities to drought impacts. Dow and Lackstrom attended the NIDIS-ACF Annual Meeting at Lake Lanier, GA on December 1-2, 2011.
- Planning and facilitating an informational meeting about the pilot project. This meeting was held at the NOAA in the Carolinas conference on March 15, 2012. Approximately 25 people from various federal and state agencies attended.
- Establishing a Steering Committee for the Carolinas NIDIS project. The committee includes 13 people including representatives from the DOI Southeast Climate Science Center, EPA Region 4, Hollings Marine Laboratory, National Drought Mitigation Center, NERRS (North Inlet-Winyah Bay), NOAA’s Center for Coastal Environmental Health and Biomolecular Research, NOAA’s Center for Excellence for Oceans and Human Health, NOAA’s Coastal Services Center, NOAA Fisheries, NOAA Regional Climate Services, The Nature Conservancy, USFWS Coastal Programs, and USGS (SC Water Science Center). A “kick-off” meeting was held at Fort Johnson, SC, on May 1, 2012.
- Planning and participating in regular conference calls with NIDIS staff and the Steering Committee to plan a NIDIS Carolinas Pilot Project Scoping Workshop. This workshop is scheduled for July 31-August 1, 2012, in Wilmington, NC.

Southeast Indigenous Peoples’ Center (SIPC) domestic water quality monitoring project. Drought is known to affect groundwater quantity and quality on both short- and long-term time scales. Rural populations dependent on household wells for domestic water supply may be

especially vulnerable to elevated pollutant concentrations. CISA is conducting well monitoring and data analysis activities in order to investigate the relationships between drought and domestic water supply and quality. Contact was made with Walker Dan Davis, Chief of the Georgia Tribe of the Eastern Cherokee in Dahlonega, GA, and Vonnie McCormick, Principle Chief of the Lower Muskogee Creek Tribe outside Whigham, GA. Tufford visited with these tribal representatives in fall 2011-winter 2012 to discuss the project and assess their property for suitable study sites. Tufford and a field technician installed small shallow monitoring wells at the two locations in April 2012. The Chiefs and spouses were trained how to use the monitor device and will take measurements once every two weeks. Water samples from the wells were also collected and brought to USC for laboratory analysis.

5.2 WATERSHED MODELING

Our hydrological modeling projects address a regional need for a comprehensive analysis of watersheds to understand how climate variability and change affects water supply and quality from the mountains to the coast. Our focus on climate as a driving force and our use of models that cover large watersheds at sub-watershed scales provide meaningful information for local and regional decision making. The projects and modeling work described below are interrelated and have evolved as we have received feedback from decision-makers about their interests in understanding the plausible range of climate change scenarios for the region.

5.2.1 Modeling of the Winyah Bay Watersheds (Tufford, Patel, Gao, Carbone, Samadi)

Abstract: We use EPA's BASINS Hydrologic Simulation Program-Fortran (HSPF) model to address hydroclimatological variability in the Winyah Bay watershed. We have calibrated HSPF simulation models for the Yadkin Pee-Dee (from the NC mountains to the SC coast), Waccamaw, and Black Rivers at the 8-digit HUC level so that local variability within each watershed can be adequately addressed. This basin-wide approach to hydrological modeling appeals to a range of stakeholders, including water managers, natural resource managers (e.g. National Wildlife Refuges, state parks), Riverkeepers, citizen-advocates, Native American peoples, and state and national regulatory agency staff.

Progress and Results: Most of the effort this year was focused on three tasks. One is the continuation of efforts to understand disaggregation from daily to hourly precipitation time series for input to the HSPF model. The second task focused on how to set up HSPF to simulate reservoirs. The third task was the writing of two manuscripts about the modeling work. The first manuscript will cover the basic setup, calibration, and verification of streamflow and water quality in the Winyah Bay watersheds. The second manuscript describes use of the HSPF model to address some specific questions relating to climate change scenarios and the relative impacts on water quality of adaptation versus mitigation options. Additional Year 1 efforts have centered around gaining a better understanding of how the model behaves with respect to meteorological drivers and their effect on model performance. There are strong spatial and temporal scale-dependencies with this that will influence the outcome and interpretation of scenario analysis in response to stakeholder needs.

Stakeholder Interactions and Presentations

- Brosius attended and met with stakeholders at the South Carolina Environmental Conference, Myrtle Beach, SC, March 12, 2012.
- Brosius attended and met with stakeholders at the 14th Annual Water Resources Research Institute Conference, Raleigh, NC, March 27-28, 2012.
- Tufford and Brosius attended and met with stakeholders at the quarterly meeting of the Cape Fear Arch Conservation Collective, Kure Beach, NC, May 15, 2012.

5.2.2 Integrating Regional Downscaling and Hydrological Models (Carbone, Gao, Kabela, Samadi)

Partner: USGS South Carolina Water Science Center (P. Conrads)

Abstract: Stakeholders have expressed interest in the development of climate scenarios for water planning. To this end, CISA is using dynamical and statistical downscaling to assess the regional impacts of climate variability and change in the southeast. We are exploring the effects climate-related changes may have on water quality, particularly on dissolved oxygen. Our downscaling efforts center around two data sets: regional climate model (RCM) output from the North American Regional Climate Change Assessment Program (NARCCAP) and statistically downscaled data from the Department of Interior/United States Geological Survey (DOI/USGS).

Progress and Results: We have been working with climate change scenarios produced for the USGS (Geo Data Portal). These data are derived from nearly 20 general circulation models (GCMs) as part of the Intergovernmental Panel on Climate Change (IPCC). Values of maximum and minimum temperature and precipitation were downscaled to a 12 km grid, commensurate with a widely-used observed gridded data set (Maurer et al. 2007)¹. We have processed downscaled data from four GCMs, including CCSM3, ECHO-2, GFDL2.0, and PCM. We have begun to work with a statistical downscaling data set from the DOI/USGS. These data for the Southeast represent the historical period, 1980-2009 and include daily precipitation, daily maximum and minimum temperature. We have processed these data to create suitable input values for the HSPF hydrological model. The gridded downscaling has been aggregated to sub-basins within and beyond the Santee Basin. Aggregation at this scale matched that required for hydrological modeling with HSPF. Data preparation also required disaggregating daily precipitation to hourly time steps. We have done extensive testing to evaluate HSPF performance with various disaggregation methods. We also have been evaluating NARCCAP data in the Southeast. We have evaluated summer and winter maximum and minimum temperature, and precipitation for nine pairs of general circulation models and regional climate models.

Leveraged Funding Sources

- “Climate change-induced changes in flow regime, floodplain inundation and species habitats.” Kupfer, J.A., G. Carbone, D. Tufford and K. Meitzen. US Department of the Interior, National Park Service, Climate Change Program, Congaree National Park. 2010-2013: \$310,000 awarded. (2011 funding: \$140,000).

¹ Maurer, E.P., L. Brekke, T. Pruitt, and P.B. Duffy. 2007. Fine-resolution climate projections enhance regional climate change impact studies, *Eos Trans. AGU*, 88(47), 504.

- “Coastal Climate Extension Specialist Support.” Carbone, G.J. SC Sea Grant Consortium/NOAA, \$18,429, 1 July 2011–30 June 2012.

5.2.3 Lower Cape Fear Watershed Study (Montz)

Partners: NC Department of Environment and Natural Resources (W. Howard, D. Rayno)

Abstract: Using the Lower Cape Fear watershed and its subwatersheds as a study area, this project aims to assess water availability and use over time, under different scenarios, at several temporal and spatial scales. This project will involve documenting past, current, and potential future patterns of water availability (i.e., supply) and past, current, and potential future patterns of demand, by land use and by sector and will incorporate various climate change scenarios.

Progress and Results: To date, progress has been made in a number of the focal points of the Cape Fear Basin climate induced water resource research. Watersheds showing potential stress in the future have been identified, based not only on varying climate predictions, but population growth and impervious cover projections. Additionally, a thorough review of the local water supply “plans” (which are more like water distribution data tables that include projections) has aided our research in identifying potential at risk areas in the future (published by North Carolina Department of Environment and Natural Resources).

Stakeholder Interactions and Presentations

- Griffin, M.T. and B. Montz. 2012. “Emerging Water Stress in Southeast North Carolina.” The Association of American Geographers Annual Meeting, New York, NY, February 24-28, 2012.
- Montz shared preliminary results of the project at the Cape Fear Arch Conservation Collective quarterly meeting, Kure Beach, NC, May 15, 2012.

5.3 COASTAL CLIMATE

CISA partners with North and South Carolina Sea Grant to assist coastal communities and stakeholders in addressing potential impacts of climate variability and change on major coastal issues including: erosion, invasive species, land use change, salt water intrusion, health of fisheries, agriculture, tourism, coastal community development, and natural hazards. The project works with government agencies in both states to better inform those individuals and to evaluate possible impacts through an applied research program.

CISA’s Coastal Climate program was established as the Carolinas Coastal Climate Outreach Initiative (CCCOI) in 2007. Since that time, CISA has worked with many different coastal stakeholders to assist them in mainstreaming climate information into decision-making processes. Evidence is growing that the CCCOI is acquiring a reputation for coastal climate outreach both in the region and nationwide. PI Jess Whitehead’s expertise was sought for reviewing grant proposals submitted to NOAA’s Great Lakes Climate Extension Capacity Building program, Michigan Sea Grant, the Mississippi-Alabama Sea Grant Consortium, Georgia Sea Grant, Virginia Sea Grant, and the NOAA RISA program. She has served as an advisory committee member for the development and proposal process for the EPA/FEMA smart growth and climate change partnerships for community technical assistance in North Carolina.

Partners: NC Sea Grant, SC Sea Grant Consortium, NOAA Coastal Services Center, College of Charleston, Environmental Protection Agency (EPA), Kitchen Table Climate Study Group of McClellanville, SC, Town of McClellanville, SC, Beaufort County (SC) Planning Department, National Sea Grant Office, National Weather Service Offices (Charleston, SC; Newport, NC), National Estuarine Research Reserves, NC Department of Environment and Natural Resources (DENR), NC Interagency Leadership Task Force Climate Working Group, North Inlet-Winyah Bay National Estuarine Research Reserve, Oregon Sea Grant, Town of Plymouth, NC, Renaissance Computing Institute at East Carolina University, SC Department of Health and Environmental Control (SC DHEC), SC Department of Natural Resources (SC DNR), US Federal Emergency Management Agency (DHS, FEMA), Georgia Sea Grant, Florida Sea Grant, Mississippi-Alabama Sea Grant, Governor’s South Atlantic Alliance, NOAA/NCDC Southern Region Climate Services Director, NOAA/NCDC Eastern Region Climate Services Director

Leveraged Funding Sources

- “Carolinas Coastal Climate Outreach Initiative – Phase II – 2010-12.” M.R. DeVoe, SC Sea Grant and M. Voiland, NC Sea Grant, PIs; R. Bacon, SC Sea Grant Extension, and G. Carbone, Univ. of South Carolina, co-PIs; J.C. Whitehead, SC Sea Grant Consortium/NC Sea Grant, J.F. Thigpen III, NC Sea Grant, K. Dow, Univ. of South Carolina, and D. Tufford, Univ. of South Carolina, additional investigators. Project duration: July 2010 – June 2012. Funds awarded \$192,702 (matching funds: \$48,176).

5.3.1 Coastal Climate Outreach (Whitehead, Carbone, Dow, Tufford)

Abstract: This project aims to inform and educate coastal decision-makers of the implications of climate variability and change for major coastal issues.

Progress and Results: We provided information on climate impacts and adaptation through numerous formal and informal outreach and extension presentations. Whitehead was consulted as an expert in coastal climate outreach by the North Carolina Interagency Leadership Team’s Climate Adaptation Working Group, which is assembling a statewide report on climate adaptation priorities in North Carolina. Whitehead participates in the South Carolina Coastal Information Network quarterly meetings. This group of coastal outreach providers and constituencies partners in order to enhance coordination of coastal community outreach efforts in the state.

Stakeholder Interactions and Presentations

- Whitehead, J. 2011. “Why is it so hard to talk about climate?” North Carolina Beach, Inlet, and Waterway Association Coastal Local Governments Meeting, Wrightsville Beach, NC, November 14, 2011.
- Whitehead, J. 2011. “Engaging APNEP Communities on Climate Change.” Albemarle-Pamlico National Estuary Program State of the Sounds Symposium: Charting a New Course, New Bern, NC, November 17, 2011.
- Whitehead, J. C., R. Bacon, J. Thigpen, G. J. Carbone, K. Dow, and D. L. Tufford. 2012. “Matching technology to audience needs: Lessons learned from the Carolinas Coastal

Climate Outreach Initiative.” Poster presented at the 92nd Annual Meeting of the American Meteorological Society, New Orleans, LA, January 23-24, 2012.

5.3.2 Community Climate Adaptation and Resilience Projects (Whitehead, Dow, Carbone)

Partners: Beaufort County, SC; NC Sea Grant; SC Sea Grant Consortium; Massachusetts Sea Grant; Maine Sea Grant; Social and Environmental Research Institute (SERI).

Abstract: The purpose of these projects is to provide tailored, decision-relevant information to coastal communities and decision makers on (a) the implications of climate variability and change, (b) adaptation strategies that increase resilience to those impacts, and (c) evaluate the utility of this adaptation support process in different settings. We work with communities to develop adaptation planning projects and pursue opportunities to transfer the tools and information gained through those processes to other communities.

Progress and Results: In Year 1 we have pursued projects intended to further develop and refine decision-support tools and products emerging from recently completed CISA and SARP research projects. Projects have focused on advancing the Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) tool and related research.

VCAPS Training. One set of activities involved disseminating information about the VCAPS tool to decision makers and providing VCAPS training sessions to other outreach specialists. Because VCAPS communities all expressed the value of outside facilitation, the research team turned its attention to how to train appropriate outside facilitators who could use the VCAPS process in their communities. The team completed a user guide² in 2011 to help outreach staff facilitate VCAPS exercises and provided training sessions for outreach personnel in Sea Grant, the National Estuarine Research Reserve System (NERRS) Coastal Training Program, cooperative extension, and others. This training will enable them to use the Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) tool when requested by communities. This will enable VCAPS to be part of a long-term sustainable process that facilitates discussions on the outcomes and consequences of climate hazards for coastal user groups, particularly local and regional governments and resource managers.

Stakeholder Interactions and Presentations

- Dow, K., T. Webler, S. Tuler, J. Whitehead, N. Kettle. 2012. “Developing vulnerability and consequence planning scenarios for adaptation.” Climate Adaptation Futures: Second International Climate Change Adaptation Conference, Tucson, AZ, May 29-31, 2012.
- Tuler, S. 2012. Invited presentation, “Improving Understandings of Consequences, Vulnerabilities, and Adaptation Strategies to Climate Change Related Hazards.” MIT Sea Grant, Cambridge, MA, February 8, 2012. http://seagrant.mit.edu/press_releases.php?ID=292

² Tuler, S., T. Webler, K. Dow, J. C. Whitehead. 2011. *Diagramming Climate Change-Related Vulnerability-Consequence Adaptation Planning Scenarios (VCAPS): A facilitation guide and tutorial*. Greenfield, MA: Social and Environmental Research Institute, 34 pp. <http://www.seri-us.org/sites/default/files/VCAPS%20UserGuide.15July11.pdf>.

- Tuler, S. T. Webler, K. Dow, J. Whitehead. 2012. “Helping Coastal Communities Adapt to Climate Change Using the Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) Process.” Social Coast Forum, Charleston, SC, February 15-16, 2012.
- Tuler, S., T. Webler, J. Whitehead. 2012. Vulnerability and Consequences Adaptation Planning Scenarios (VCAPS) Training. Mississippi-Alabama Sea Grant Consortium webinar, March 1, 2012.
- Whitehead, J. S. Tuler, T. Webler, K. Dow, N. Kettle, K. Miller. 2012. “Facilitating Community Resiliency Discussions Using the Vulnerability Consequences Adaptation Planning Scenarios (VCAPS) Process.” 2012 NOAA in the Carolinas Conference: Water Resources and Resiliency, Fort Johnson, SC, March 15-16, 2012.

New VCAPS Projects. Planning is underway for several new projects. These projects will expand upon previous VCAPS work and related research. First, Whitehead has initiated a new partnership with Beaufort County, SC, on climate change planning and sea level rise. A second project entitled “Promoting climate change awareness and adaptive planning in Atlantic fisheries communities” will involve working with VCAPS in three new towns (South Thomaston, Maine, New Bedford, Massachusetts, and Beaufort, SC).

Leveraged funding sources:

- “Promoting climate change awareness and adaptive planning in Atlantic fisheries communities using dialogue-based participatory vulnerability analysis, mapping, and collaborative systems dynamic modeling.” T. Webler, S. Tuler, J. Whitehead, and E. Stancioff. NOAA Climate Program Office Coastal and Ocean Climate Applications (COCA). \$268,600. September 2012 – August 2014.
- “Sea Grant Climate Adaptation 2011: Beaufort County, SC – Using Participatory Scenario Building to Encourage Climate-Resilient Zoning in the Coastal Carolinas.” J. Whitehead, A. Turner, T. Webler, and S. Tuler. NOAA National Sea Grant Coastal Communities Climate Adaptation Initiative (CCCAI). Awarded, \$99,778. April 2012 – January 2014.

5.3.3 Regional and National Climate Outreach Projects (Whitehead, Brosius)

Abstract: These projects aim to increase the capacity of the Sea Grant network, on a regional and national scale, to target and support relevant research and deliver directed outreach programs on the impacts of climate variability, climate change, and adaptation strategies for coastal stakeholders.

Progress and Results: Whitehead is engaged in several activities intended to support regional – and national – collaboration among climate outreach professionals. Activities include:

- As co-chair for the Steering Committee of the Sea Grant Climate Network, Whitehead assists with coordinating grassroots support for climate outreach throughout the Sea Grant network.
- Whitehead participated in the Governors’ South Atlantic Alliance Annual Meeting and Disaster Resilient Communities Technical Team Meeting in Savannah, GA, on September 7-8, 2011.
- In May 2010, CISA and the SC and NC Sea Grant programs were part of a workshop to establish a new community of practice for NOAA entities involved in coastal climate adaptation along the south Atlantic coast. The initiative was funded by the National Sea

Grant Office and the NOAA Southeast and Caribbean Regional Team (SECART). Since then Whitehead has supported and promoted the “Southeast and Caribbean Climate Extension and Outreach Community of Practice” by working with other partners to secure funding and plan a 2012 workshop entitled “Considering Climate in Decision Support for Resilient Coastal Communities.” The purpose of the conference is to provide information about climate science and decision-support tools to individuals and organizations engaged in community planning and hazard management. Whitehead and Brosius (CISA’s Outreach Specialist) were involved in planning the workshop and preparing materials and resources for the participants. Konrad presented on climate trends and projections. The conference was held on June 12-14, 2012, in Jacksonville, FL.

5.4 HEALTH

5.4.1 *Assessing Heat Stress Vulnerability* (Konrad)

Partners: NC State Climate Office, NC Division of Public Health, UNC Chapel Hill School of Emergency Medicine, UNC School of Public Health

Abstract: Researchers at the Southeast Regional Climate Center (SERCC) are investigating heat stress vulnerability and assessing methods to improve existing warning systems. The SERCC is presently working with data from the North Carolina Disease Event Tracking and Epidemiologic Collect Tool (NC DETECT) to examine relationships between heat and morbidity across North Carolina. The long term 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 and South Carolina and 2) develop empirical relationships that can be exploited to build tools that translate recent, current, and predicted weather/climate conditions across the Carolinas into useful information regarding the probability of different types of public health emergencies (e.g. spikes in heat related morbidity/mortality).

Progress and Results: The project lead was able to incorporate a much longer and detailed time series of the NC Detect database, which records most emergency room visits in North Carolina, into a relational database. The data was expanded from a 3-yr time series with only a primary diagnosis to a 5-yr series with secondary, tertiary diagnoses, etc. This work also included pilot work to investigate demographic patterns of heat morbidity at the census tract level across the Piedmont and Coastal Plain regions of North Carolina. The pilot work, using the shorter time-series, indicates that the increased heat morbidity observed in rural areas is especially prevalent in agricultural areas, especially where labor-intensive crops (e.g. tobacco and vegetables) are grown. There is, however, much intra-census tract variability that relates partly to the vagaries of a small sample size (e.g. two warm seasons of admissions data). With the much longer time series currently under investigation, we will be in better position to test this working hypothesis.

Leveraged Funding Source

- Southeast Regional Climate Center, NOAA, \$643,688, April 1, 2011 – March 31, 2012.

Stakeholder Interactions and Presentations

Konrad communicated parts of this work at invited presentations including:

- Writer’s workshop for NCA Southeast Technical Report held in Atlanta, GA, September 26-27, 2011.
- Climate Conversations Workshop held in Charleston, SC, January 13, 2012.
- Southeast NCA Health Sector Meeting held in Charleston, SC, February 13-14, 2012.

5.4.2. Assessing the Impacts of Climate Variability on Water Quality Conditions and Vibrio in North Carolina and South Carolina Estuaries (Tufford, Scott, Moore)

Partners: UNC Institute of Marine Science (R. Nobel), USC Department of Environmental Health Science

Abstract: This project integrates our work on watersheds, coastal adaptation, and drought and will investigate human health threats posed by the marine bacterium *Vibrio* in shellfish. The spread of *Vibrio* is believed to be associated with changing temperature and salinity conditions. Models in North and South Carolina will be developed to monitor and assess the potential for increased exposure to *Vibrio* bacterial hazards in the southeastern U.S. coastal water under changing salinity trends. Potential human health impacts make this work of value to both North and South Carolina Shellfish programs.

Progress and Results: Detailed project planning was completed as well as the recruitment of a graduate student to do work at the CCEHBR on laboratory analysis of water and sediment samples for *Vibrio*. Water and sediment sampling sites were selected - five on the Waccamaw River, one at the mouth of the Black River, and three in Winyah Bay. In order to establish a sampling plan and protocol, researchers worked with the field sampling crew at CCEHBR. The first sampling trip occurred April 2012, analysis is currently underway. Sampling is scheduled for every month through October 2012. The Neuse River Estuary in North Carolina was selected as the second research site. No additional sampling is required for this project element because our partners, Dr. Rachel Nobel and her staff and students of the UNC Institute of Marine Science, are already sampling and have been for several years. Nobel and colleagues will share their results with CISA. A USC graduate student has been hired to take the *Vibrio* sampling results and integrate them with results from the salinity intrusion modeling work CISA completed as part of the SARP project, “Assessing the Impact of Salt-Water Intrusion in the Carolinas under Future Climatic and Sea-Level Conditions.”

Leveraged Funding Sources: CCEHBR is contributing significant personnel time and expense to perform their part of the project. Additional personnel include six members of the field sampling crew and supervisor. Additional resources provided by CCEHBR include trucks, boats, gasoline, and expendable field and lab supplies.

5.5 ADAPTATION

5.5.1. Supporting Improved Natural Resource Planning through Climate Workshops (Mizzell, Abramyan)

Abstract: CISA is assisting the SC DNR State Climatology Office in hosting workshops about climate and its impacts on South Carolina’s natural resources. These workshops are intended to

engage DNR staff and stakeholders, including non-governmental organizations, local government leaders, elected officials, corporate landowners, and utility representatives. The goal is to discuss how climate information can lead to improved natural resource planning and decisions and increase awareness of how species and ecosystems in South Carolina are affected by climate.

Progress and Results: The idea for the workshops was discussed with a number of agencies, including the Association of Fish and Wildlife Agencies, the National Estuarine Research Reserve System (NERRS), SC Sea Grant Consortium, U.S. Fish and Wildlife Service South Atlantic Landscape Conservation Cooperative, NOAA Southeast Regional Climate Center, SC Wildlife Federation, and NOAA Coastal Services Center. Several meetings were conducted with the SC Department of Natural Resources State Wildlife Action Plan coordinator and her Deputy Director to identify potential workshop participants and workshop goals. The workshops were also discussed with the SCDNR Climate Change Technical Working Group. Mizzell met with CISA staff to seek input on the agenda and workshop goals. Mizzell also spoke with representatives that published the National Fish, Wildlife and Plants (NFWP) Climate Adaptation Strategy and attended two of their public comment workshops. The goal of this Strategy is to nationally facilitate principles and practices and safeguard the nation's biodiversity, ecosystem functions and human use of fish, wildlife and plants in a changing climate. This group is interested in participating in the workshops to share expertise and determine how the NFWP strategy can assist and improve SC's response capability. Lastly, research on South Carolina climate trends and variability, including the influence of ENSO on winter weather, was conducted. This research will be presented at the climate workshops.

Stakeholder Interactions and Presentations

- Abramyan, I. "The Influence of ENSO Cold and Warm Event Cycles on South Carolina's Winter Weather." Palmetto Chapter of the American Meteorological Society Annual Mini-Technical Conference, Columbia, SC, March 15, 2012.
- Mizzell, H. Public Workshop on the National Fish, Wildlife and Plants Climate Adaptation Strategy, Charleston, SC, February 7, 2012.
- Mizzell, H. Online Webinar on the National Fish, Wildlife and Plants Climate Adaptation Strategy, February 22, 2012.
- Mizzell, H. SCDNR Climate Change Technical Working Group Meeting, Columbia, SC, February 22, 2012.
- Mizzell, H. "South Carolina's Climate Report Card: Understanding South Carolina's Climate Trends and Variability." Palmetto Chapter of the American Meteorological Society Annual Mini-Technical Conference, Columbia, SC, March 15, 2012.

5.5.2. Research and Communications in Support of Adaptation (Dow, Lackstrom, Brosius, Carbone)

Abstract: Supporting improved adaptation to current climate variability and projected climate changes is a cross-cutting element of CISA's core focus areas and projects. To support adaptation efforts, CISA's research efforts strive to: build regional understanding of climate variability and change, impacts and vulnerabilities; identify climate-related data and management needs; support networks for sharing information and expertise; develop analytical

approaches and tools to aid in decision making; and improve the communication of climate risks and uncertainties. Because much of climate adaptation is and will be comprised of local actions, our efforts focus on informing local response to regional climate patterns and on major economic, environmental management, and social issues relevant throughout the region.

Progress and Results: The CISA team had many opportunities to share CISA research findings and engage with stakeholders on topics related to climate adaptation, including arranging opportunities for stakeholders to participate in regional and national discussions. One partner commented in an email, “I just wanted to say thanks one more time for bringing me down to Charleston. This was one of the best meetings I’ve attended in a long time, and really re-charged my batteries! I’m looking forward to finding opportunities to establish a formal connection with CISA, something we can start exploring over the next few weeks.” Specific activities and presentations are listed below.

In addition, the CISA team is addressing needs identified through research conducted in support of the National Climate Assessment (2010-2012). This effort focused on identifying key climate sensitive decisions, improving our understanding of decision-support needs, and assessing the multiple dimensions of adaptive capacity in the region and is now helping to inform next steps in working with regional decision makers in climate-sensitive sectors. Two follow-up activities are already in the planning and development stages. The first project will be a CISA newsletter to provide syntheses of climate science articles of relevance to decision makers in the Carolinas and information about upcoming events, meetings, and conferences related to climate issues (expected start date: late summer 2012). The second project will be a “Carolinas Climate Conference.” The intent of this conference is to provide information about climate research, services, and tools available to decision makers in the Carolinas and to facilitate communication, coordination, and information-sharing among climate service providers, researchers, and decision makers in the region. A preliminary proposal was presented and discussed at the CISA Advisory Committee meeting in March 2012. Further work will begin in late summer 2012.

Stakeholder Interactions and Presentations

- Brosius and Whitehead attended the North Carolina Climate Adaptation Strategy Workshop, Raleigh-Durham Airport, NC, November 10, 2011. Whitehead participated in the NC Interagency Leadership Team Climate Change Working Group Sea Level Rise Planning Session, Raleigh, NC, September 16, 2011 and helped to facilitate the stakeholder input/sea level rise break-out group session at the workshop.
- Brosius, Konrad, and Mizzell attended the “Climate Conversation” conducted by The Keystone Center, Charleston, SC, January 13, 2012.
- Brosius attended the “Project Design & Evaluation Workshop” sponsored by the NOAA Coastal Services Center, Fort Johnson, SC, April 3-4, 2012.
- Brosius attends NCAnet monthly conference calls (ongoing).
- Carbone, Dow, Whitehead, and Mizzell attended the “Climate Science in Support of Coastal Management” Meeting, Charleston, SC, January 10-11, 2012.
- Carbone, G. 2012. Invited member of the Climate Science and Impact Assessment Panel. Climate Science in Support of Coastal Management, Charleston, SC, January 10-11, 2012.

- Carbone, G. 2012. “The Science Behind Global Climate Change.” Invited webinar presentation for the Southern Alliance for Clean Energy, May 16, 2012. http://www.cleanenergy.org/index.php/?Webinar-Archive-Detail.html?item_id=59.
- Dilling, L., K. Dow, M. C. Lemos, K. Lackstrom, J. Berggren, S. Kalafatis, B. Haywood, R. Henry. 2012. “Toward a framework for assessing stakeholder needs in responding to climate change across spatial and temporal scales.” 92nd American Meteorological Society Annual Meeting, New Orleans, LA, January 22-26, 2012.
- Dow, K., K. Lackstrom, A. Brennan, A. Brosius, B. Haywood, N. Kettle. 2012. “Building adaptive capacity through partnerships and networks.” Climate Adaptation Futures: Second International Climate Change Adaptation Conference, Tucson, AZ, May 29-31, 2012.
- Dow serves as a member of the Science Implementation Panel for the SE Climate Science Center and contributes to proposal review processes
- Dow, K. provided an “Introduction to the Process for the Development of the Southeast Technical Contribution to the National Climate Assessment” at the meeting of Southeastern Natural Resources Leadership Group in Savannah, GA, November 2, 2011.
- Haywood, B., A. Brennan, K. Lackstrom, N. Kettle, K. Dow. 2012. “Framing Climate Change in the Carolinas: The Influence of Perceived Risks, Institutional Priorities, and Public Support.” Climate Adaptation Futures: Second International Climate Change Adaptation Conference, Tucson, AZ, May 29-31, 2012.
- Kettle, N. 2011. “Climate Change Adaptation Planning in Coastal South Carolina.” 2011 SouthEastern Division of the Association of American Geographers Annual Meeting, Savannah, GA, November 20-22, 2011.
- Kettle, N. 2012. “Climate Change Adaptation Planning in Coastal South Carolina.” Social Coast Forum. Charleston, SC, February 15-16, 2012.
- Kettle, N. 2012. “The influence of perceived risk, uncertainty, and trust on coastal climate change adaptation planning.” 2012 Annual Meeting of the Association of American Geographers, New York, NY, February 24-28, 2012.
- Kettle, N. 2012. “Theoretical perspectives on support for coastal climate change adaptation planning.” Poster presented at Climate Adaptation Futures: Second International Climate Change Adaptation Conference, Tucson, AZ, May 29-31, 2012.
- Lackstrom, K. 2012. “Climate decision making in the Carolinas: the role of information networks in supporting adaptation.” Poster presented at Climate Adaptation Futures: Second International Climate Change Adaptation Conference, Tucson, AZ, May 29-31, 2012.
- Turner, A. and J. Whitehead. 2012. “Assessing Flooding Adaptation Needs in the City of Charleston, SC.” 2012 NOAA in the Carolinas Conference: Water Resources and Resiliency, Fort Johnson, SC, March 15-16, 2012.

6. LINKS WITH OTHER NOAA PROGRAMS

CISA typically engages with decision makers in collaboration with others, including NOAA or NOAA-sponsored entities. Collectively, we seek synergy, not duplication, viewing our role as a RISA to identify user needs for climate information, to conduct research that is shaped by, and done in collaboration with users, and to establish an iterative process that refines our investigations, leads to effective communication of results and, where appropriate, long-term access to decision-support tools.

NOAA organizations and agencies with formal connections to CISA are listed in the table below. Partnerships range from research to outreach to consultation and information sharing on emerging climate issues. In addition, several members of the CISA team (Brosius, Carbone, Dow, Konrad, Lackstrom, Mizzell, Patel, and Tufford) participated in the 2012 NOAA in the Carolinas conference, held at Fort Johnson, SC, March 15-16 2012. The purpose of these meetings is to encourage and provide opportunities for coordination and partnerships across NOAA offices in the region.

Organization/Agency/Division	Role/Relationship to CISA
Center for Coastal Environmental Health and Biomolecular Research (CCEHBR)	Collaborating Investigator and project partner: “Assessing the Impacts of Climate Variability on Water Quality Conditions and Vibrio in North Carolina and South Carolina Estuaries”
National Estuarine Research Reserve System	Project partner: Coastal Climate
NCDC	Advisory Committee member
NIDIS	Project partner: Coping with Drought
NOAA Climate Services-Eastern Region	Advisory Committee member
NOAA Coastal Services Center	Project partner: Coastal Climate; Advisory Committee member
North Carolina Sea Grant	Collaborating Investigator and project partner: Coastal Climate; Advisory Committee member
North Carolina State Climate Office	Collaborating Investigator and project partner: Drought Sensitivity Testing
Northeast Regional Climate Center	Project partner: DDIT
NWS	Project partner: Coastal Climate
South Carolina Sea Grant Consortium	Collaborating Investigator and project partner: Coastal Climate; Advisory Committee member
South Carolina State Climate Office	Collaborating Investigator and project partner: Supporting Improved Natural Resource Planning through Climate Workshops
Southeast Regional Climate Center	Principal Investigator and project partner: Assessing Heat Stress Vulnerability
Southeast and Caribbean Regional Team	Project partner: Coastal Climate