



INTEGRATING CLIMATE SCIENCE AND WATER MANAGEMENT IN THE CAROLINAS:
CAROLINAS INTEGRATED ASSESSMENTS AND SCIENCES (CISA) ANNUAL REPORT
Submitted: 29 April 2011

Project Title: Integrating Climate Science and Water Management in North and South Carolina (NA06OAR4310007)

Performance Period: 1 May 2010 – 30 April 2011

Team Members:

PIs: Greg Carbone, Kirstin Dow, Hope Mizzell, Dan Tufford, Jessica Whitehead

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1. CURRENT AREAS OF FOCUS

CISA conducts applied climate research in collaboration with a wide range of water and coastal stakeholders across the Carolinas. Three general focus areas characterize both the science and outreach: drought, watershed modeling, and coastal climate. During the 2010-2011 reporting period, we have also conducted research to support the National Climate Assessment. Within each of these areas, we are pursuing 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.

2. MAIN STAKEHOLDERS AND PARTNERS

- Albermarle-Pamlico National Estuary Program
- Cape Fear Arch Conservation Collaborative
- Catawba-Wateree Drought Management Advisory Group
- City of Charleston, SC
- Clemson University
- Climate Assessment for the Southwest (CLIMAS)
- Congaree National Park
- Environmental Protection Agency
- Great Lakes Integrated Sciences and Assessments (GLISA)
- Kitchen Table Climate Study Group
- National Climatic Data Center
- National Drought Mitigation Center (NDMC)
- National Estuarine Research Reserve System (NERRS)
- National Integrated Drought Information System (NIDIS)
- National Weather Service
- NOAA Center for Coastal Ocean Science
- NOAA Coastal Services Center
- North Carolina Department of Environment and Natural Resources
- North Carolina State Climatologist
- North Carolina Urban Water Consortium
- Northeast Regional Climate Center
- Renaissance Computing Institute (East Carolina University)
- Sea Grant Programs (NC, SC, OR)
- Social and Environmental Research Institute
- South Carolina Coastal Information Network

- South Carolina Dept. of Health and Environmental Control, Office of Coastal Resource Management
- South Carolina Department of Natural Resources
- South Carolina Water Resources Center
- Southeast Indigenous Peoples' Center
- Southeast Regional Climate Center
- State Climate Offices (AL, FL, GA, NC, SC, VA, Puerto Rico)
- Town of McClellanville, SC
- Town of Plymouth, NC
- Town of Sullivan's Island, SC
- United States Geological Survey
- University of North Carolina
- Waccamaw Riverkeeper-Winyah Rivers Foundation
- Water Resources Research Institute
- Yadkin-Pee Dee Drought Management Team

3. RESEARCH FINDINGS

- Map readers found strategies using variations in saturation, opacity, texture, fill clarity, and extrinsic elements most intuitive for visualizing uncertainty at points.
- Community adaptation planning was enhanced by working within a structured mediated modeling setting supported by interactive mapping of vulnerability, consequences, and management options.
- Investigation of multiple approaches to improve water quality and quantity modeling in coastal plains where low, flat elevation poses a challenge to flow models. Comparison of radar precipitation and weather station inputs into hydrological models did not result in significant model improvements.
- Our dynamic downscaling results in the southeast conform with others in that the largest amount of uncertainty in regional climate change projections is derived from choice of GCM (Deque et al., 2007; Jacob et al., 2007) with RCM choice accounting for the second largest amount of uncertainty (Giorgi, 2006).¹ We also found that:
 - Temperature change projections indicate warming trend for each month with highest increases in summer, early fall, and December (over 2.5°C warming).
 - Temperature increase projections are lowest in late winter and early to mid spring (less than 1.75°C warming).
 - Wetter conditions are projected for February through May (7.3% average increase) with drier conditions projected for June through September (11.5% average decrease).
 - Spatial patterns of January and August temperature change are similar between RCM and driving GCM.
 - Spatial patterns of January precipitation are similar between RCM and driving GCM, however, August precipitation change projections show disconnect between RCM and GCM.

¹ Deque, M., D. P. Rowell, D. Luthi, F. Giorgi, J. H. Christensen, B. Rockel, D. Jacob, E. Kjellstrom, M. de Castro, and B. van den Hurk. 2007. An intercomparison of regional climate simulations for Europe: assessing uncertainties in model projections. *Climatic Change* 81:53-70.

Jacob, D., L. Barring, O. B. Christensen, J. H. Christensen, M. de Castro, M. Deque, F. Giorgi, S. Hagemann, G. Lenderink, B. Rockel, E. Sanchez, C. Schar, S. I. Seneviratne, S. Somot, A. van Ulden, and B. van den Hurk. 2007. An inter-comparison of regional climate models for Europe: model performance in present-day climate. *Climatic Change* 81:31-52.

Giorgi, F. 2006. Regional climate modeling: Status and perspectives. *Journal De Physique Iv* 139:101-118.

4. ACCOMPLISHMENTS

- Significant progress has been made towards refining functionality of the Dynamic Drought Index Tool (DDIT) and transferring the tools to the Applied Climate Information System (ACIS).
- Water quantity calibration and verification was completed for all watersheds in the Yadkin-Pee Dee Basin using EPA's BASINS Hydrologic Simulation Program-Fortran (HSPF) model. Water quality calibration began for all of the watersheds and was completed for two watersheds.
- The Vulnerability Consequence Adaptation Planning (VCAPs) mediated modeling approach was tested in two communities and efforts for further testing and dissemination of the model are underway.
- Regional-national networks on coastal climate adaptation are established and growing.
- The Sea Grant Climate Network was one of six organizations nominated for George Mason University Center for Climate Change Communication's 2011 Climate Change Communicator of the Year Award.
- A CISA External Advisory Committee was formed and met via conference call. This committee represents diverse regional expertise and knowledge of climate service needs in the Carolinas. Organizations represented include: Kitchen Table Climate Study Group, McClellanville, SC; NC Sea Grant; NOAA Coastal Service Center; NOAA National Climatic Data Center (NCDC); NC Division of Coastal Management, SC DHEC Office of Coastal Resource Management, SC Department of Health and Environmental Control; SC Sea Grant Consortium; SC Water Resources Center, Clemson University; U.S. EPA Region 4; Water Resources Research Institute (WRRI), University of North Carolina.
- Mizzell developed a process and inventory, the "Climate Change Impacts to Natural Resources Document Management System," to evaluate available resources within the SC Department of Natural Resources. This system enhances the agency's ability to assess and address climate impacts as they relate to South Carolina's natural resources.
- A total of 13 publications were completed.
- The team offered a total of 44 presentations - 34 in professional, workshop, and stakeholder meetings and 11 in education and outreach settings.

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

CISA Investigators: G. Carbone, J. Rhee, K. Dow, J. Fowler

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

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: In 2010-11 we have focused on refining functionality of the DDIT and transferring the tool to the ACIS used by the Regional Climate Centers. This work involved writing code to accommodate ACIS web services in order to make the DDIT compatible with the ACIS. We successfully used web services to retrieve station precipitation and temperature data and have begun to test additional web services for linking SPI (Standardized Precipitation Index) values with spatial features. We have also been testing server-side SVG rendering. Appropriate changes to the DDIT and ACIS were discussed during a series of teleconferences and visits among the research team. For example, the 50-year base period (1950 – 2004) was changed to a 40-year period (1970s – present) to be used for the eastern US considering the data availability of the entire region. The types of spatial features handled by the ACIS (along with metadata) will be expanded to include various scales of watersheds and region-specific layers of the DDIT, such as the SC Drought Management Areas.

We have also made significant progress on our work to display uncertainty in drought mapping. A cognitive cartographic study measured user interpretation of uncertainty symbols in drought maps. The most *intuitive* symbols for expressing uncertainty were saturation, opacity, fill clarity 1 and 2, extrinsic2, and texture 3. Subjects *perceived* extrinsic 2, fill clarity 1, opacity, area filled, and saturation as most effective at communicating drought data’s uncertainty (Figure 1). We also learned that subjects are less likely to interpret the symbols accurately when the drought level at a station is not the same as the drought level for the area of interest.

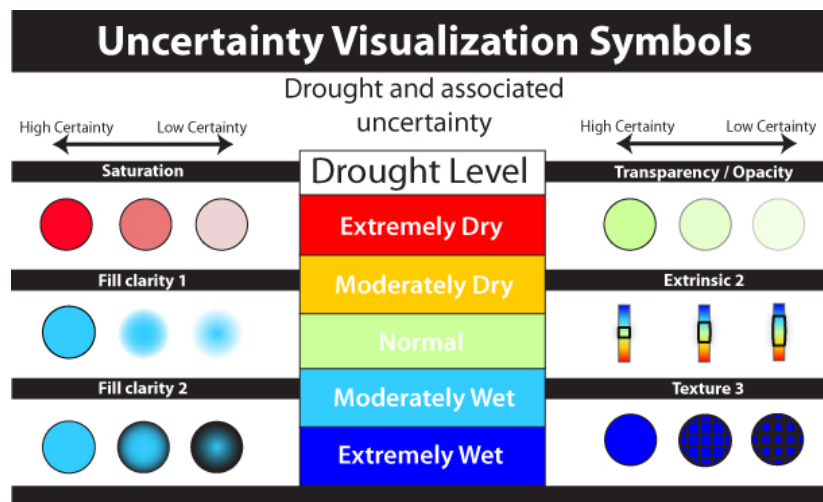


Figure 1. Uncertainty Visualization Symbols Tested for Drought Mapping Applications

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

5.1.2 Advancing Regional and Local Capacity to Cope with Drought

CISA Investigators: K. Dow, D. Tufford, K. Lackstrom

Partners: National Integrated Drought Information System (NIDIS), National Drought Mitigation Center (NDMC), Southeast Regional Climate Center (SERCC), NC and SC State Climate Offices, Southeast Indigenous Peoples' Center (SIPC), NC Urban Water Consortium

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 2010-2011 we have continued and initiated 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.

Research to Understand Regional Needs for a Drought Early Warning System. In Fall 2009 CISA initiated workshops to learn about drought concerns, assess stakeholders' use of drought data and preferences for new tools and information, and assess users' requirements for a drought early warning system. We completed writing two technical reports based on research examining these issues with NC urban water systems and stakeholders involved in SC coastal ecosystems.

Drought and Coastal Ecosystems State of Knowledge Report. We are developing a state-of-knowledge report focused on understanding drought impacts in the Carolinas' coastal environments. These efforts are based on participant recommendations from the workshop mentioned above. We hired an ecologist with extensive experience working on the southeastern coast to take the lead in reviewing literature and writing the report.

Southeast Indigenous Peoples' Center (SIPC) domestic water quality monitoring project. Concerns about drought impacts on groundwater quantity and quality for rural populations led us to partner with SIPC understand whether vulnerability to water quality problems is elevated during drought and determine whether water level or water quality provide early indicators of drought onset or severity. Tufford is currently working with SIPC (Lori Johnston) to initiate well monitoring and data analysis activities intended to investigate the relationships between drought and domestic water supply and quality.

Leveraged Funding Sources: We received a supplement to our core funding of \$34,020.

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

CISA Investigators: D. Tufford, L. Felker

Abstract: We use EPA's BASINS Hydrologic Simulation Program-Fortran (HSPF) model to address hydroclimatological variability in high growth areas of the Winyah Bay watershed (Figure 2). We have consulted a wide range of stakeholders to develop our basin-wide approach to hydrologic modeling.

Progress and Results: Water flow calibration and verification was completed for all watersheds in the Yadkin-Pee Dee Basin. Water quality calibration began for all of the watersheds and was completed for two watersheds. Water quality constituents include water temperature, biological oxygen demand, dissolved oxygen, and total ammonia-nitrogen, depending on the availability of observed data for each watershed. Four watersheds in the upper regions of the watershed were unable to be calibrated for water quality because of a lack of water quality data in this region.

The alternative stream geometry creation method in HSPF was adapted for use in the Coastal Plain. We manually created stream geometry using increasing channel roughness values. Sensitivity runs were conducted for two watersheds to test whether the best values had been used for calibrating water quantity. Results indicated that the best parameter values were currently being used for these two watersheds. The sensitivity of water quality parameters was evaluated using HSPF-PARM to aid in calibration. This provided a starting point for water quality calibration, with the ranges of parameter values used by other researchers displayed, and the sensitivity of each parameter in the model based on sensitivity runs.

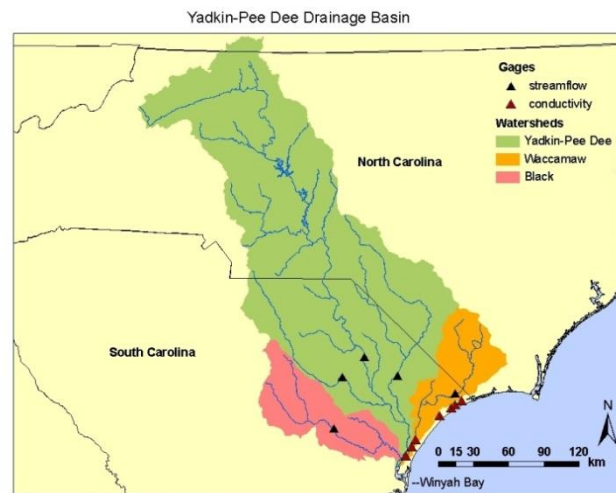


Figure 2. Winyah Bay Watersheds

Current and ongoing watershed modeling activities reflect stakeholder feedback. In June 2010 we shared the watershed models and initial results with 15 decision makers from organizations such as Waccamaw Watershed Academy, Waccamaw Riverkeeper, and Horry County Stormwater Management in order to elicit feedback, aid ongoing model development, and integrate local watershed concerns into scenario development. Participants suggested that the models could be used to improve understanding of dissolved oxygen (DO) dynamics in the Waccamaw River, especially under scenarios of changing precipitation patterns. The Waccamaw River is DO stressed, which is common in coastal rivers. However, prior research at Coastal Carolina University has shown that the periods of lowest DO do not occur under the conditions that regulators account for when setting discharge limits.

5.2.2 Assessing the Impact of Salt-Water Intrusion in the Carolinas under Future Climatic and Sea-Level Conditions

CISA Investigators: J. Whitehead, D. Tufford, K. Dow, G. Carbone, L. Felker
Partners: USGS SC Water Science Center (P. Conrads), Advanced Data Mining (E. Roehls)

Abstract: This project assists stakeholders in the Yadkin-Pee Dee River basin of NC and SC prepare for potential changes in the frequency and magnitude of salt water intrusion under future climatic conditions. The project uses the EPA BASINS HSPF model and the “Pee Dee River and Atlantic Intracoastal Waterway Salinity Model” (PRISM) (Conrads and Roehl (2007)).² The final product will be a new, web-based Decision Support System (DSS) for decision makers to examine potential salinity intrusion scenarios and provide information that will help them plan for future severe events (e.g., positioning fresh-water intakes and treatment facilities, preparing for increased treatment costs). Participatory workshops and focus groups are used to receive feedback on stakeholders’ needs and disseminate project results.

Progress and Results: The project is under a no cost extension through June 2011 due to delays in receiving funding and unanticipated delays in acquiring downscaled climate scenarios. The completion of water quantity calibration for the Winyah Bay watershed (described above) allowed us to prepare HSPF output data for test runs with PRISM (Conrads and Roehl 2007). A Thiessen polygon weighted approach was used to better represent precipitation on the Coastal Plain for flow calibration. This method was extended from the original calibration period of 1988-1992 to include the test intervals for PRISM from July 1995 through August 2009. Work was also done to help prepare past and future climate scenarios to understand the impacts of these scenarios on water quantity and quality. This progress allowed Dow and Whitehead to conduct 8 semi-structured interviews in August 2010 with water managers and other water quality stakeholders in Georgetown and Conway, SC. These decision-makers provided input on the types of scenarios of salt water intrusion under climate change that would be useful, appropriate temporal and spatial scales for scenarios, and the use of scenarios to explore adaptive options and other issues of concern to water managers.

Leveraged Funding Sources: “Assessing the impact of salt-water intrusion in the Carolinas under future climatic and sea-level conditions.” J. Whitehead, PI (originally G. Zielinsky, PI); D. Tufford, Dept. of Biology, Univ. of South Carolina, Co-PI; K. Dow and G. Carbone, Dept. of Geography, Univ. of South Carolina, Co-PIs. NOAA SARP #NA08OAR4310715. Duration of Study: May 2008 – extended to June 2011. Funds awarded: \$235,717.

5.2.3 Integrating Regional Downscaling and Hydrological Models

CISA Investigators: G. Carbone, P. Gao, E. Kabela
Partners: USGS South Carolina Water Science Center (P. Conrads)

² Conrads, P.A. and Roehl, E.A., Jr. 2007. Analysis of salinity intrusion in the Waccamaw River and Atlantic Intracoastal Waterway near Myrtle Beach, South Carolina, 1995-2002. U.S. Geological Survey Scientific Investigations Report 2007-2110, 41 p.

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: Analysis has focused on an assessment of RCM performance in the Southeast during the historical period, with explanations of model bias, as well as quantification of uncertainty in future scenarios that results from differing models and downscaling methods. We have examined monthly temperature and precipitation changes using a verification data set of 12km gridded observed dataset from 1970 to 1999 from the University of Washington (Maurer et al., 2002), 50km RCM historical (1970-1999) and future (2041-2070) output from NARCCAP (Mearns et al., 2009).³ We created probability density functions (PDFs) for the observed dataset and each RCM in historical period using extracted data and used the PDFs to determine monthly model skill. This was accomplished by calculating cumulative minimum value of two distributions of a binned value, measuring the common area between two PDFs (Perkins et al., 2007).⁴ Skill is based on a scale from zero (low skill) to one (high skill) and used to calculate weighted average for future precipitation and temperature change.

Figure 3 shows monthly skill scores for RCM3-GFDL, WRF3-CCSM3, and MM5I-CCSM3 RCMs (a) temperature and (b) precipitation for the period 1970-1999 for the Southeast U.S. RCMs show some skill in modeling historical temperature, especially during the warm months, but show little skill in modeling cold season historical temperature. Precipitation skill scores are low for all months. MM5I-CCSM3 RCM shows highest overall skill with WRF3-CCSM3 RCM showing least skill.

Figure 4 shows projected temperature and precipitation change for the Southeast U.S. from 1970-1999 to 2041-2070. Green boxes represent weighted average of three RCMs; whiskers represent lowest and highest individual model mean.

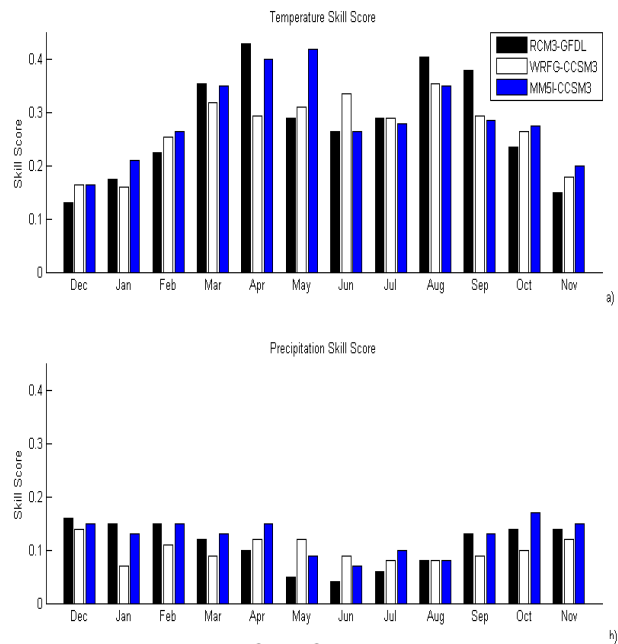


Figure 3. Monthly Skill Scores for Temperature and Precipitation 1970-1999

³ Maurer, E. P., A. W. Wood, J. C. Adam, D. P. Lettenmaier, and B. Nijssen. 2002. A long-term hydrologically based dataset of land surface fluxes and states for the conterminous United States. *Journal of Climate* 15:3237-3251.

Mearns, L. O., W. Gutowski, R. Jones, R. Leung, S. McGinnis, A. Nunes, and Y. Qian. 2009. A regional climate change assessment program for North America, *Eos Trans. AGU*, 90(36), 311- 312.

⁴ Perkins, S. E., A. J. Pitman, N. J. Holbrook, and J. McAneney. 2007. Evaluation of the AR4 climate models' simulated daily maximum temperature, minimum temperature, and precipitation over Australia using probability density functions. *Journal of Climate* 20:4356-4376.

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 been processing data as it becomes available and conforming it to serve as input for our hydrological modeling work.

Leveraged Funding Sources:

- “Assessing the impact of salt-water intrusion in the Carolinas under future climatic and sea-level conditions.” NOAA SARP #NA08OAR4310715. Duration of Study: May 2008 – June 2011. Funds awarded: \$235,717.
- “Climate Change-Induced Changes in Flow Regime, Floodplain Inundation and Species Habitats at Congaree National Park.” Kupfer, J., G. Carbone, D. Tufford, W. Graf. Department of Interior, \$312,608.

5.2.4 Climate Impacts on Congaree National Park

CISA Investigators: G. Carbone, D. Tufford

Partners: University of South Carolina Department of Geography (J. Kupfer, W. Graf)

Abstract: This project is intended to improve understanding of the effects of climate change on riparian systems at Congaree National Park. Project objectives include: constructing regional precipitation and temperature scenarios from downscaled general circulation models, developing profiles of river hydrology under varying climate change scenarios, translating profiles of river hydrology into corresponding maps of site hydroperiod, and producing maps of potential habitat for key indicator species at Congaree under both current conditions and projected scenarios of environmental change.

Progress and Results: CISA’s downscaling work (discussed above) is a key component of this project. As downscaling results continue to be developed, they will serve as inputs into multiple model simulations to analyze the effects of altered river hydrology, floodplain inundation and resultant species distribution across the Congaree landscape.

Leveraged Funding Sources: “Climate Change-Induced Changes in Flow Regime, Floodplain Inundation and Species Habitats at Congaree National Park.” Kupfer, J., G. Carbone, D. Tufford, W. Graf. Department of Interior, \$312,608.

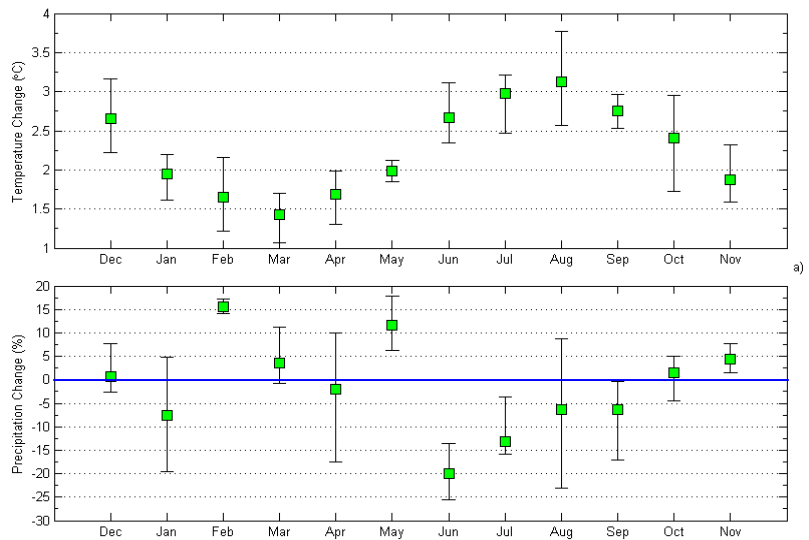


Figure 4. Projected Temperature and Precipitation change for the Southeast U.S. from 1970-1999 to 2041-2070

5.3 COASTAL CLIMATE

CISA partners with North and South Carolina Sea Grant to assist coastal communities and stakeholders address 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 same individuals and to evaluate possible impacts through an applied research program. Our long-term goal is for stakeholders in the coastal Carolinas to mainstream climate information into decision-making processes.

5.3.1 The Carolinas Coastal Climate Outreach Initiative (CCCOI)

CISA Investigators: G. Carbone, K. Dow, D. Tufford, J. Whitehead
Partners: NC Sea Grant, SC Sea Grant Consortium

Abstract: In 2006 the South Carolina Sea Grant Consortium, North Carolina Sea Grant, and CISA created a climate extension program. This program integrates the climate and vulnerability expertise of CISA researchers with the stakeholder interaction experience of both Sea Grant programs to provide timely, relevant, and credible information on climate issues to decision-makers along the North and South Carolina coasts.

Progress and Results: The CCCOI program serves as a model for similar climate extension programs across the country. Whitehead has served as regional climate extension specialist (RCES) since 2008. To date, activities include over 45 RCES presentations and posters given to stakeholder and scientific audiences and the development of a collaborative research and outreach program described in further detail below. These projects have been supported by additional awarded leveraged funds.

Leveraged Funding Sources:

- “The Carolinas Coastal Climate Outreach Initiative.” M. R. Devoe, R. Bacon, G.J. Carbone, J. Thigpen, D. Tufford, K. Dow, and J. Whitehead. 2006-2010. NOAA National Sea Grant Office and Climate Program Office.
- “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).

5.3.2 Informing Coastal Management Adaptation Planning and Decision Making for Climate Change Using an Interactive Risk-based Vulnerability Assessment Tool

CISA Investigators: K. Dow, J. Whitehead, N. Kettle, K. Miller
Partners: Town of Sullivan’s Island, SC; Town of McClellanville, SC; Social and Environmental Research Institute (SERI), MA (S. Tuler, T. Webler)

Abstract: The purpose of this research is to create a tool that will help decision-makers in small municipalities to explore the potential outcomes and consequences of climate change in their towns, along with pathways through which they and individuals may respond.

Progress and Results: A mediated modeling approach was used to facilitate a total of six workshops in two coastal communities in South Carolina. The team developed the tool in partnership with the Town of Sullivan’s Island, SC. After initial interviews, the team facilitated four structured diagramming workshops with town staff and elected officials in May 2010. The group members created user-generated diagrams to identify current management challenges that may be intensified by climate change and identified strategies to improve long-term planning efforts. An Adobe Flash-based computer diagramming tool was used to help organize and record what was learned. The group decided that the facilitated process catalyzed discussion on climate change that would not otherwise have occurred. The process benefited Sullivan’s Island stakeholders by helping them learn about diverse perspectives and understand complex management issues under climate change in ways they said would not have been possible had the diagrams been completed by an outside party. Participants found this mediated modeling process helpful in identifying several “no regret” strategies, trade-offs, cross-scalar barriers, and potential innovative strategies. This approach also deepened the research team’s understanding about local adaptation processes. In response, the research team refined the tool and packaged it as part of an overall facilitated modeling methodology called the VCAPS (Vulnerability and Consequence Adaptation Planning Scenario) process. In March-April 2011, the team repeated the VCAPS process with a group of decision-makers from McClellanville, SC. The process focused on stormwater, and as a result, elected officials participating in the exercise asked for assistance from CISA and SC Sea Grant to create a town stormwater plan that accommodates increasing rainfall variability. They also requested a repeat VCAPS exercise at a later date to focus a second diagramming discussion on preserving the character of their historic fishing village under climate change. Research results have been presented at the Annual Meeting of the American Meteorological Society National Conference and the Land Grant and Sea Grant National Water Conference. A workshop on this approach will be presented at the National Coastal Zone conference in July 2011. This workshop will teach other extension agents and outreach professionals to facilitate this process in other communities, thus broadening the benefits of VCAPS to small coastal communities nationwide.

Leveraged Funding Sources: “Informing Coastal Management Adaptation Planning Using an Interactive Risk-Based Vulnerability Assessment Tool.” S. Tuler, Social and Environmental Research Institute, Greenfield, MA, PI; T. Webler, SERI, co-I; K. Dow, Dept. of Geography, Univ. of South Carolina, co-I; J. Whitehead, SC Sea Grant Consortium, co-I. NOAA SARP #NA09OAR4310151. Duration of study: August 2009 –March 2011. Funds awarded: \$213,886.

5.3.3 Coastal Community Climate Adaptation and Resilience Projects

CISA Investigators: J. Whitehead, K. Dow, G. Carbone

Partners: NC Sea Grant; SC Sea Grant Consortium; Town of Plymouth, NC; City of Charleston, SC; Town of McClellanville, SC; Kitchen Table Study Group; Oregon Sea Grant

Abstract: The purpose of these projects is to work with coastal communities to facilitate climate resilience and adaptation planning and to identify infrastructure vulnerabilities and adaptation options for current climatic events as well as expected future risks associated with climate change (e.g., increased tidal flooding frequency under sea level rise).

Progress and Results: Planning and implementation is underway for several projects funded by the Sea Grant Coastal Communities Climate Adaptation Initiative (CCCAI).

Plymouth, North Carolina. Partners at the Renaissance Computing Institute (RENCI) of East Carolina University mapped historical patterns of erosion in Plymouth and sea level rise scenarios for the town. Whitehead, Putnam, and Covi conducted 15 mental modeling interviews in August-September 2010 with community leaders in order to establish a baseline of community knowledge, attitudes, and personal behavior towards the environment in general and flooding in particular. The team is in the process of analyzing these interviews to develop an outreach strategy that will assist the town in exploring potential impacts of more frequent flooding exacerbated by sea level rise and identifying adaptation options.

Charleston, South Carolina. In partnership with the City of Charleston, SC, the NOAA Coastal Services Center (CSC), and the College of Charleston, the South Carolina Sea Grant team is investigating potential sea level rise impacts and adaptation options for flooding on the Charleston peninsula. Whitehead, Turner, and CSC staff conducted a focus group with nine members of the City of Charleston planning and engineering staff and consultants on tidal flooding perceptions in downtown Charleston. The focus group members also gave feedback on “Visualizing Shallow Coastal Flooding and Sea Level Rise in Charleston, South Carolina,” a CSC product on increases in tidal flooding frequency with 0.5 m of sea level rise (<http://www.csc.noaa.gov/digitalcoast/action/chsflood.html>). Based on feedback from this group, CSC made extensive revisions and issued a new two-page fact sheet on historical tidal flooding trends in Charleston, which focus group members found more defensible and decision-relevant than maps of future projections that did not realistically account for stormwater infrastructure impacts on flooding patterns. The team is currently working with the City of Charleston to develop an outreach strategy that will help the City initiate discussions on sea level rise adaptation in a challenging sociopolitical and economic context.

McClellanville, South Carolina. In fall 2010 Whitehead worked with the Kitchen Table Climate Study Group (KTCSG) to develop a strategy to catalyze adaptation planning activities. In January 2011 Whitehead led the first advisory committee meeting to assess community risks and resilience in McClellanville, a study funded as part of Oregon Sea Grant’s SARP project, “Mobilizing the NOAA Sea Grant Network for Coastal Community Climate Resilience.” This advisory committee includes CISA scientists (Carbone, Dow, Whitehead) and McClellanville elected officials, managers, and residents. One outcome of this meeting was that the advisory committee members wanted to participate in a facilitated VCAPS exercise, which has provided an opportunity to integrate the Tuler et al. and Cone et al. SARP projects.

Leveraged Funding Sources:

- “Preparing for Climate Change: Helping Small Coastal Communities Develop Adaptive Strategies.” J. Thigpen, NC Sea Grant, PI; G. Putnam, NC Sea Grant, J. Whitehead, SC Sea

Grant Consortium, co-PIs. NOAA National Sea Grant Coastal Communities Climate Adaptation Initiative (CCCAI) program. Project duration: May 2010-October 2010. Funds awarded: \$30,000. (Plymouth, NC project)

- “Preparing for Climate Change: Helping Small Coastal Communities Develop Adaptive Strategies.” J. Thigpen, NC Sea Grant, PI; G. Putnam, NC Sea Grant, co-I; J. Whitehead, SC Sea Grant Consortium & NC Sea Grant, co-I. Subcontract of SARP project “Mobilizing the NOAA Sea Grant Network for Coastal Community Climate Resilience” (J. Cone, OR Sea Grant, PI). Project duration: May 2010-June 2011. Funds awarded: \$14,000. (Plymouth, NC)
- “Assessing Flooding Adaptation Needs in the City of Charleston, SC.” R. Bacon, SC Sea Grant Extension, PI; A. Turner, J. Whitehead, SC Sea Grant Consortium, co-PIs. NOAA National Sea Grant Coastal Communities Climate Adaptation Initiative (CCCAI) program. Project duration: May 2010-October 2010. Funds awarded: \$30,000. (Charleston, SC project)
- “Using Citizen Social Science to Investigate Climate Change Vulnerability and Resilience in McClellanville, SC.” J. Whitehead, SC Sea Grant Consortium & NC Sea Grant, PI; R. Bacon, SC Sea Grant Extension, co-I, S; D. Stoney, Kitchen Table Climate Study Group, McClellanville, co-I. Subcontract of SARP project “Mobilizing the NOAA Sea Grant Network for Coastal Community Climate Resilience” (J. Cone, OR Sea Grant, PI). Project duration: September 2010-June 2012. Funds awarded: \$14,000. (McClellanville, SC project)

5.4 NATIONAL CLIMATE ASSESSMENT

CISA Investigators: K. Dow, K. Lackstrom, H. Mizzell, B. Haywood, S. Ferguson, N. Kettle

Partners: SERCC, SECC, GLISA, WWA, State Climate Offices of Alabama, Florida, Georgia, North Carolina, Puerto Rico, South Carolina, Virginia

Abstract: In support of the National Climate Assessment (NCA), CISA is conducting an array of studies to identify key climate sensitive decisions, improve our understanding of decision-support needs, and assess the multiple dimensions of adaptive capacity in the region.

Progress and Results: In addition to the research projects discussed below, CISA PIs have supported NCA planning efforts on regional and sectoral approaches (Reston, VA, November 2010), vulnerability assessment (Atlanta, GA, January 2011), and a work session to develop a sea level rise and coastal resources climate sensitivity assessment for the NC Department of Environment and Natural Resources (DENR). The NC process will assist NCDC to develop a regional climate model as part of the overall NCA.

5.4.1 Collaboration with Key Climate Service Providers. We are partnering with the Southeast Regional Climate Center (SERCC), the Southeast Climate Consortium (SECC), and the state climatologists of the SERCC to document and evaluate climate information requests made of their offices. We have collaboratively developed an on-line climate information request reporting system for the region’s state climate offices (SCOs) and begun monthly data analysis. CISA is coordinating the data coding and production of summaries. This systematic effort will help us

identify shared concerns and needs and inform the coordination and development of climate service efforts. Preliminary results from the South Carolina SCO illustrate this approach. SCO staff surveyed customers to determine how they integrate climate information into their day-to-day operations as well as their long-term plans. 190 customer assessments were completed from September 15, 2010 to March 31, 2011. Requests were coded to determine the types of information needed, the range of individuals and sectors requesting information, differences in the specificity of information needs; the climate sensitive decisions being made, and the capacity of the SCO to meet the user needs. Figure 5 indicates the types of requests made for climate information. In addition, 27% of the survey respondents indicated they currently conduct planning that integrates climate variability (or plan to within the next year).

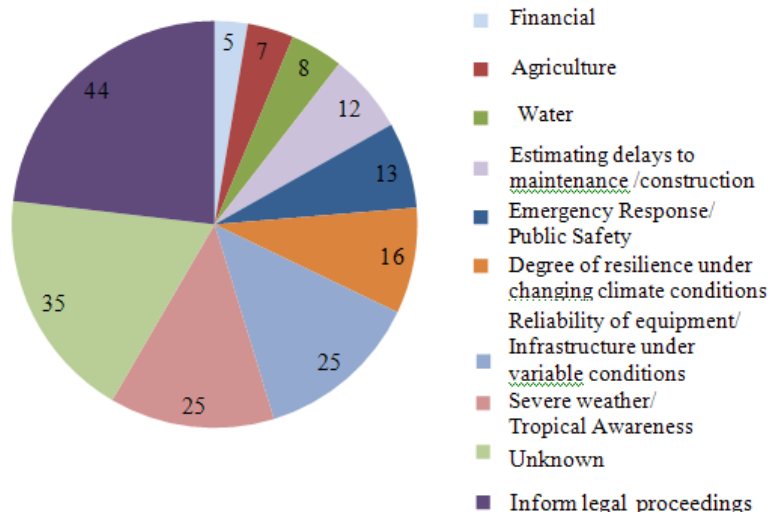


Figure 5. SC SCO Climate Service Requests

5.4.2 Engaging Climate-Sensitive Sectors, Decisions, and Peoples. We are focusing on regionally significant sectors and planning processes, including recreation and tourism, forestry, wildlife and habitat conservation planning, water- and wastewater systems, urban sustainability initiatives, and needs of southeast indigenous peoples. The first component of this project is to use existing documents to analyze stakeholders’ engagement with climate adaptation activities, climate-related needs, and the networks that facilitate information sharing. We are collaborating with two other RISAs (GLISA, WWA) to design and implement the evaluation framework. We have collected over 130 documents, and the first stages of document and social network analysis are complete. In the second component of the project we will conduct coupled questionnaires-interviews with key decision-makers and opinion leaders in the sectors listed above. Through these methods we will obtain more in-depth information about the communication networks that exist to support decision-making, adaptations occurring within the various sectors, how those decisions and adaptations interact with other plans and initiatives, and the major limitations in the capacity of their sector to adapt. Approximately 180 potential interviewees have been identified; protocols for this phase are awaiting IRB approval.

6. COMMUNICATING SCIENCE TO DECISION MAKERS

6.1 Presentations (Academic and Stakeholders, Total 34)

Carbone, G. “Climate Change and the Southeast United States and Caribbean.” *Southeast and Caribbean Regional Team (SECART) Workshop*, Jacksonville, FL, May 24, 2010.

- Carbone, G. "Global Climate Change." Palmetto Bluff Conservancy. Bluffton, SC, December 3, 2010.
- Conrads, P. "Estimating Salinity Intrusion Effects Due to Climate Change Along the Grand Strand of the South Carolina Coast." 4th Federal Interagency Hydrologic Modeling Conference, Las Vegas, NV. June 27-July 1, 2010.
- Conrads, P. A., Roehl, E. A., Daamen, R. C., Cook, J. B., Sexton, C. T. "Development of Decision Support Systems for Estimating Salinity Intrusion Effects due to Climate Change on the South Carolina and Georgia Coast." South Carolina Water Resources Conference, Columbia, SC, October 13-14, 2010.
- Dow, K. Panel Member. "Putting Geography into Practice and the U.S. National Climate Assessment." Annual Meeting of the Association of American Geographers. Seattle, Washington, April 12-16, 2011.
- Felker, L. "Approaches to Improve Calibration of Hydrologic Models in Coastal Plains." South Carolina Water Resources Conference, Columbia, SC, Oct. 13-14, 2010.
- Felker, L. "Increased Perviousness versus Urban Densification: Trade-offs between Adaptation and Mitigation in a Changing Climate." American Water Resources Association Spring Specialty Conference, Baltimore, MD, April 18-20, 2011.
- Felker, L., Tufford, D. L., Carbone, G. J., Grego, J. M., Gao, P. "Approaches to Calibrate Watershed Hydrologic Models in the Southeast Coastal Plain." 2010 Annual Water Resources Conference, Philadelphia, PA, Nov. 1-4, 2010.
- Kettle, N. P. Trust in state-level climate change adaptation planning. Association of American Geographers Annual Conference; Seattle, WA; 12-16 April 2011.
- Lackstrom, K. "Drought Adaptations and Institutions in the Carolinas." Annual Meeting of the Association of American Geographers, Seattle, WA, April 14, 2011.
- Mizzell, H. South Carolina Climate Trends and Outlooks Presentations.
 - Monthly Updates, SC Dept. of Natural Resources Monthly Board Meetings.
 - Greenwood Clemson Extension Annual Banquet, Greenwood, SC, May 10, 2010.
 - Bi-annual Meeting of the Clemson Extension Advisory Council, Georgetown, SC, August 11, 2010.
 - Columbia Downtown Optimist Club, Columbia, SC, October 5, 2010.
 - Dillon County Palmetto Leadership Meeting, Dillon, SC, November 22, 2010.
 - SC Watermelon Growers Association, Columbia, SC, January 14, 2011.
 - Clemson Extension-Newberry Cattlemen's Association, Newberry, SC March 24, 2011.
 - Low Country Utility Committee, Charleston, SC, March 2, 2011.
- Mizzell, H. "South Carolina State Climatology Office Update."
 - Coastal Services Center/ACE Basin NERR "Roadmap for Adapting to Coastal Risks Training" workshop, Bluffton, SC, June 2, 2010.
 - Annual Meeting of the American Association of State Climatologists, Lake Tahoe, CA, July 12-16, 2010.
 - Southeast Regional Climate Center Technical Advisory Committee Annual Meeting, Tallahassee, FL, February 22, 2011.
- Mizzell, H. "South Carolina Climate Crunch." Crunch 2010: Interstate Water Issues Conference, Greenville, SC, September 23-24, 2010.
- Mizzell, H. "Droughts, FERC Relicensings, and Water Management Benefits." Third Annual South Carolina Rivers Forum: A Decade of Hydropower Reform and the Benefits to South Carolina's Rivers, Columbia, SC, October 15, 2010.

- Mizzell, H. "Overview of Climate in SC and State Office of Climatology." An Introduction to *AgroClimate* Workshop, Pee Dee Research and Education Center, Florence, SC, January 14, 2011.
- Tufford, D. L., Felker, L. "Watershed Simulation Modeling of the Waccamaw River and Greater Winyah Bay for Water Resource Management Decision-Making." Burroughs and Chapin Center for Marine and Wetland Studies Seminar, Coastal Carolina University, Conway, SC, June 24, 2010.
- Tuler, S., Dow, K., Whitehead, J. C., Webler, T., Kettle, N. P. "Integration of local planners' and scientists' knowledge of consequences, vulnerabilities, and adaptation strategies to climate change related hazards." 91st Annual Meeting of the American Meteorological Society, Seattle, WA, January 23-27, 2011.
- Whitehead, J. "Engaging decision-makers on climate change." Southeast Coastal Ocean Observing Regional Association annual meeting, Savannah, GA. May 12, 2010.
- Whitehead, J. "Using climate extension to assist coastal decision-makers with climate adaptation." The 22nd Meeting of The Coastal Society, Wilmington, NC. June 16, 2010.
- Whitehead, J. Workshops and Trainings.
- "Climate change and the Carolinas: a BRIEF overview." SARP project, Sullivan's Island structured diagramming group, Sullivan's Island, SC. May 6, 2010.
 - National Sea Grant Office/NOAA Southeast and Caribbean Regional Team Southeast and Caribbean Climate Outreach Workshop, Jacksonville, FL. May 25, 2010.
 - Coastal Services Center/ACE Basin NERR "Roadmap for Adapting to Coastal Risks Training" workshop, Bluffton, SC. June 2, 2010.
 - "COSEE-SE Ocean Institute 2010, Raleigh, NC. June 24-25, 2010.
 - Sapelo Island NERR "Preparing for Climate Change" workshop, Savannah, GA, July 28, 2010. (with A. Turner)
- Whitehead, J. C., Turner, A., Bacon, R. H., Putnam, G., Thigpen, J. F., Covi, M. "Comparing climate extension approaches to catalyze climate change adaptation planning in Charleston, SC, and Plymouth, NC." 91st Annual Meeting of the American Meteorological Society, Seattle, WA, January 24, 2011.

6.2 Poster Presentations (Total 4)

- Fowler, J. "Communicating the Certainty of Drought Data." South Carolina Water Resources Conference, Columbia, SC, October 13-14, 2010.
- Kabela, E. "Downscaling climate change information for water resource and agricultural interests in the southeast." Climate Prediction Applications Science Workshop, Des Moines, IA, March 1-4, 2011.
- Tufford, D. L., Felker, L., Carbone, G. "Hydrologic and water quality modeling of the Yadkin Pee Dee and Waccamaw River watersheds." 2011 WRI Annual Conference and NCWRA Symposium, Raleigh, NC, March 22-23, 2011.
- Tuler, S., Webler, T., Dow, K., Kettle, N., Miller, K., Whitehead, J. "Integration of local planners' and scientists' knowledge of consequences, vulnerabilities, and adaptation strategies to climate change related hazards." Land Grant and Sea Grant National Water Conference, Washington, D. C., January 31-February 1, 2011.

6.3 Education and Outreach (Total 11)

Carbone, G., N. Kettle. “Global Climate Change: From Science to Policy.” Duke TIP Scholar Weekend, University of South Carolina, Columbia, SC. February 12-13, 2011.

Felker, L, D. L. Tufford, G. C. Carbone, and P. Gao. Calibration of Watershed Hydrologic Models in the southeast. Web-based presentation 2011.
<http://www.cas.sc.edu/geog/research/cisa/web%20presentations/Calibration%20of%20Watershed%20Hydrologic%20Models/Calibration%20of%20Watershed%20Hydrologic%20Models.html>.

Fowler, J. Communicating Uncertainty Cartographically. Web-based presentation. 2011
http://www.cas.sc.edu/geog/research/cisa/web%20presentations/Fowler_Final/Fowler_Final.html

Kabela, E. D. P. Gao, J. Rhee, and G. C. Carbone. Downscaling Climate Change Information for Water Resources. Web-based presentation 2011.
<http://www.cas.sc.edu/geog/research/cisa/web%20presentations/Erik%20final/Erik%20final.html>

Mizzell, H. Presentations regarding South Carolina climate:

- “Weather and Climate Update,” Making It Grow, SC Educational Television, Sumter, SC, June 15, August 31, December 14, 2010.
- Question and Answer Interview, SCDNR “Your Day” Radio Program, August 4, 2010.
- “SC Weather and Climate Outlook,” USC Aiken’s spring Biology Seminar, Aiken, SC, February 11, 2011.

Whitehead, J. Presentations regarding coastal climate issues:

- “Evidence and causes of climate change.” COSEE-SE Ocean Awareness Day, Greenville, SC. October 16, 2010. (with L. Spence)
- “Climate change and adaptation in coastal South Carolina.” Beaufort GreenDrinks, Beaufort, SC. November 16, 2010.
- Kitchen Table Climate Study Group monthly meeting, McClellanville, SC, November 18, 2010.

Whitehead, J. Answered information and media requests regarding coastal climate issues:

- NOAA Sea Level Rise program, NSF-funded aquarium display project, SC Aquarium, Charleston Green Committee, SC Seafood Alliance, Charleston Post and Courier, WCIV-TV (Charleston, SC), Charlotte Observer.

6.4 Service to Committees and Other Activities

Greg Carbone

- Advisory Committee, Kitchen Table Climate Study Group
- Advisory Committee, NC Sea Level Rise Risk Management Study
- Environmental Advisory Committee, Climate and Energy Working Group, University of South Carolina
- Panel reviewer, Agriculture and Food Research Initiative Competitive Grants Program on Agricultural Water Science Program, US Department of Agriculture

Kirstin Dow

- Science Steering Committee on Adaptation, ICLEI
- Technical Advisory Committee to City of Columbia, Climate Protection Action Committee
- Environmental Advisory Committee, University of South Carolina
- Sustainability Research Committee, Office of the Vice-President for Research, University of South Carolina

- Advisory Committee, Kitchen Table Climate Study Group
- NAS Board on Atmospheric Science and Climate
- Intergovernmental Panel on Climate Change, AR5 WG2, Chapter 16 Adaptation Opportunities, Constraints, and Limits

Hope Mizzell

- Water Resources Committee, SC American Water Works Association
- Catawba Wateree Drought Management Advisory Group
- Yadkin Pee Dee Drought Management Team

Dan Tufford

- Advisory Board, Audobon South Carolina
- Board of Directors, Gills Creek Watershed Association
- EPA Integrated Modeling to Characterize Climate Change Impacts and Support Decision Making Workshop, Conference, Atlanta, GA, February 2011

Jess Whitehead

- Science Advisory Panel, The Nature Conservancy Alligator River National Wildlife Refuge Climate Adaptation project
- Science and Technical Advisory Committee, Albermarle-Pamlico National Estuary Program
- Technical Team on Disaster-Resilient Communities, South Atlantic Governors Alliance
- Advisory Committee, Kitchen Table Climate Study Group

7. PUBLICATIONS

7.1 Peer-Reviewed (Total 3)

- Kettle, N. P. 2011. "Exposing compounding uncertainties in sea level rise assessments." *Journal of Coastal Research*. (accepted)
- Rhee, J., J. Im, and G. J. Carbone. 2010. Monitoring agricultural drought for arid and humid regions using the multi-sensor remote sensing data. *Remote Sensing of Environment* 114: 2875-2887. doi: 10.1016/j.rse.2010.07.005.
- Rhee, J. and G. J. Carbone. 2011. Estimating drought conditions for regions with limited precipitation data. *Journal of Applied Meteorology and Climatology* 50: 548-559. doi: 10.1175/2010JAMC2604.1

7.2 Reports, Proceedings, and Other Publications (Total 10)

- Carbone, G., Kabela, E. 2010. "Downscaling Climate Change Information for Water Resources." *Proceedings of the 2010 South Carolina Water Resources Conference*, October 13-14, 2010. Available at http://www.clemson.edu/restoration/events/past_events/sc_water_resources/archives_2010/tl_2010_proceedings.html
- Chhotray, S. 2010. An Assessment of the Perception, Level of Involvement, and Needs of User-Groups for Marine Protected Areas in the Carolinas. Master's thesis. University of South Carolina.
- CISA. 2010. Fact sheet – Carolinas Integrated Sciences and Assessments. 2 pages.
- Lackstrom, K., Dow, K. 2010. "Coastal Ecological Impacts of Drought: Needs for a Drought

- Early Warning System.” *Proceedings of the 2010 South Carolina Water Resources Conference*, Columbia, SC, October 13-14, 2010.
- Lackstrom, K. 2011. “Institutional Opportunities and Barriers to Climate Adaptation.” 2011 American Water Resources Association Spring Specialty Conference, Managing Climate Change Impacts on Water Resources: Adaptation Issues, Options, and Strategies, Baltimore, MD, April 19, 2011.
- Lackstrom, K., Dow, K., Ferguson, S., Kettle, N. 2011. Understanding Needs for a Drought Early Warning System: Urban Water Systems in North Carolina.
- Lackstrom, K., Dow, K., Ferguson, S., Kettle, N. 2011. Understanding Needs for a Drought Early Warning System: Drought Impacts and Stresses on Coastal Ecosystems
- Kettle, N. P. 2010. Improving reporting of uncertainties in sea level rise assessments. In: *Proceedings of the 22nd International Conference; Shifting Shorelines: Adapting to the Future*. The Coastal Society. Wilmington, North Carolina. June 13-June 16, 2010.
- Mizzell, H., Carbone, G., Dow, K., Rhee, J. “Addressing monitoring needs for drought management.” *Proceedings of the 2010 South Carolina Water Resources Conference*, Columbia, SC, October 13-14, 2010. Available at http://www.clemson.edu/restoration/events/past_events/sc_water_resources/archives_2010/t1_2010_proceedings.html.
- South Carolina Sea Grant Consortium. 2011. “Sea level rise...what does it mean?”

8. LINKS WITH OTHER NOAA PROGRAMS

- Hollings Marine Laboratory
- National Estuarine Research System
- NCDC
- NIDIS
- NOAA Coastal Services Center
- NOAA in the Carolinas
- North Carolina Sea Grant
- Northeast Regional Climate Center
- NWS
- Sectoral Applications Research Program
- South Carolina Sea Grant Consortium
- Southeast Regional Climate Center
- Southeast and Caribbean Regional

8.1 Regional and National Collaborations: Formation of a Sea Grant Climate Network

CISA Investigator: J. Whitehead

Abstract: The objective of these collaborations is to increase the capacity of the Sea Grant network regionally and nationally to research and deliver outreach programs on the impacts of climate variability and change for coastal stakeholders.

Progress and Results: Regional efforts entail working with the Southeast Caribbean Regional Team (SECART) to establish a community of practice that facilitates regional collaboration on climate outreach. Whitehead helped to plan the 2010 Southeast and Caribbean Climate Outreach Workshop: “Building a Community of Practice of Climate Extension and Outreach Professionals.” Results include the facilitation of knowledge coordination among outreach professionals working on climate issues, climate adaptation training for attendees, and the development of a web-based resource portal and forum to maintain collaborations after the workshop (available through the NOAA CSC, <http://collaborate.csc.noaa.gov/>)

climateadaptation/pages/scceocp.aspx). National-level activities include involvement with the Sea Grant Climate Network (SGCN), a grassroots organization for Sea Grant employees who work with or have an interest in climate variability and climate change. The network has over 300 members and has been critical in fostering new partnerships across Sea Grant programs. In October 2010 Whitehead received a Chairman's Award (with C. Conger, Hawai'i Sea Grant) from the Assembly of Sea Grant Extension Program Leaders for her leadership efforts.

Whitehead, J. Links and collaborations with other NOAA programs.

- Co-chair, Sea Grant Climate Network Steering Committee
- Chair, Sea Grant Climate Network Southeast Regional Group
- Advisory Committee, "Enhancing Sea Grant Climate Extension Capabilities through Training and Increased Interaction with NOAA Scientists," NOAA SARP project, University of Wisconsin Sea Grant (PIs Hurley and Spangler)
- Sea Grant Coastal Processes Specialists Roundtable: Making Coastal Hazards and Climate Adaptation Work, Wilmington, NC, June 17, 2010.
- Sea Grant Week, New Orleans, LA, October 15-20, 2010.
- Southeast Regional Coastal Program & NERR Meeting, Beaufort, NC, November 8-10, 2010.

Leveraged Funding Sources:

- "Enhancing Capacity for Climate Engagement in the Southeast and Caribbean Region of the United States." C. Hopkinson, Georgia Sea Grant, PI; G. Olmi, NOAA Southeast and Caribbean Regional Team, co-I; S. Fauver, NOAA Coastal Services Center, co-I; J. Whitehead, SC Sea Grant Consortium & NC Sea Grant, co-I. Duration of project: November 2009 – October 2010. Funds awarded: \$25,000.
- "The Sea Grant Climate Network: Informing Coastal Communities on Critical Issues." R. Bacon, SC Sea Grant Extension, PI; J. Whitehead, SC Sea Grant Consortium, co-I; C. Conger, Hawai'i Sea Grant, co-I. NOAA #NA06OAR4170015, Duration of project: August 2009 – December 2010. Funds awarded: \$34,960.

9. CURRENT CROSS-RISA ACTIVITIES

- Collaboration with CLIMAS to transfer DDIT to AZ and NM
- Collaborative research to support the National Climate Assessment with the Southeast Climate Consortium (SECC). The project entails systematically documenting and evaluating climate information requests made of the State Climate Offices served by the SERCC.
- Collaborative research to support the National Climate Assessment with the Great Lakes Integrated Sciences and Assessment (GLISA) and Western Water Assessment (WWA) teams. Project includes conducting a systematic review of publications identifying information needs from diverse sectors across our regions.
- Mizzell (presenter) and Whitehead (facilitator) participated in "An Introduction to *AgroClimate*" workshop organized by investigators from the Southeast Climate Consortium and Clemson University (Pee Dee Research and Education Center, Florence, SC, January 24, 2011). Clemson extension personnel, agricultural consultants, and farmers attended and provided feedback for further development of the tool.